Q1

Five letter words, having distinct letters, are to be constructed using the letters of the word 'EQUATION' so that each word contains exactly three vowels and two consonants. How many of them have all the vowels together?

(1) 3600

(2) 1800

(3) 1080

(4) 900

Q2

Consider the system of linear equation
$x - 2y + bz = 3$
$ax + 2z = 2$
$5x + 2y = 1$
If ab $= 12$ and a $\neq 3$ then system of linear equations has -

(1) no solution

(2) infinite solution

(3) unique solution

(4) finitely many solutions

Q3

Let $P(\text{S})$ denote the power set of $S = \{1, 2, 3, \ldots, 10\}$. Define the relations R_1 and R_2 on $P(S)$ as AR_1B if $(A \cap B^c) \cup (B \cap A^c) = \Phi$ and $AR_2\, B$ if $A \cup B^c = B \cup A^c, \forall A, B \in P(S)$. Then :

(1) both R_1 and R_2 are equivalence relations

(2) only R_1 is an equivalence relation

(3) only R_2 is an equivalence relation

(4) both R_1 and R_2 are not equivalence relations

Q4

If the area of the region $\left\{ (x, y) \in R^2 : y^2 \geq 4x, |y| \leq \frac{x}{2} + 2 \right\}$ is Δ, then find the value of $[\Delta]$.

[Note: $[S]$ denotes greatest integer less than or equal to S.]

(1) 12

(2) 13

(3) 10

(4) 11

Q5

From the focus $(-5, \ 0)$ of the ellipse $\frac{x^2}{45} + \frac{y^2}{20} = 1$, a ray of light is sent which makes an angle $\cos^{-1}\left(\frac{-1}{\sqrt{5}} \right)$ with the positive direction of x-axis, upon reaching the ellipse surface, the ray is reflected from it. Slope of the reflected ray is

(1) $-\frac{3}{2}$

(2) $-\frac{7}{3}$

(3) $-\frac{5}{4}$

(4) $-\frac{2}{11}$

Q6

If the point $(\alpha, 0)$ lies inside the quadrilateral formed by lines $2x + 5y = 15, 5x - 4y = 21,$ $3x + 5y + 17 = 0$ and $y = x + 3$, then which of the following is true?

(1) Number of prime value(s) of α is 4 .

(2) Number of integral value(s) of α is 7.

(3) Minimum integral value of α is -3.

(4) Maximum integral value of α is 5.

Q7

In a ΔABC, the sides BC, CA and AB are consecutive positive integers in increasing order. Let $\vec{a}, \vec{b}$ and $\vec{c}$ are position vectors of the vertices A, B and C respectively. If $(\vec{c} - \vec{a}) \cdot (\vec{b} - \vec{c}) = 0$, then the value of $|\vec{a} \times \vec{b} + \vec{b} \times \vec{c} + \vec{c} \times \vec{a}|$ is equal to

(1) 15

(2) 16

(3) 12

(4) 9

Q8

If $x\,dy - y\log_e y\,dx + 2yx^3 \sin x\,dx + yx^4 \cos x\,dx = 0$, then solution is

(1) $y = e^{x(c - x^2 \tan x)}$

(2) $y = e^{x^2(c - x\sin x)}$

(3) $y = e^{x(c + x^2 \sin x)}$

(4) $y = e^{x^2(c + x\sin x)}$

Q9

If $a_1,\ a_2,\ a_3, \ldots., a_{20}$ are the arithmetic means between 13 and 67, then the maximum value of the product $a_1 \cdot a_2 \cdot a_3 \cdots a_{20}$ is

(1) $(20)^{20}$

(2) $(60)^{20}$

(3) $(80)^{20}$

(4) $(40)^{20}$

Q10

The number of points of non-differentiability of the function $f(x) = \max(\sin x, 2x) + [\max(\sin x, 2x)]$ (where $[\cdot]$ denotes greatest integer function) in $(0, 2\pi)$ is

(1) 12

(2) 14

(3) 17

(4) 18

Q11

Three fair coins numbered 1 and 0 are tossed simultaneously. Then variance $\text{Var}(X)$ of the probability distribution of random variable X, where X is the sum of numbers on the uppermost faces, is

(1) 0.7

(2) 0.75

(3) 0.65

(4) 0.62

Q12

If $\vec{a} = x\hat{i} + y\hat{j} + z\hat{k}, \vec{b} = \hat{i} + \hat{j} + \hat{k}$ where $x, y, z \in \{0, 3, -3, 6, -6\}$, then the number of non-zero vectors $\vec{a}$ such that $\vec{a} \cdot \vec{b} = 0$ are

(1) 20

(2) 18

(3) 15

(4) 12

Q13

Let $f : R \to R$ be a polynomial function satisfying the equation $f(f(x)-2y) = 2x - 3y + f(f(y)-x)$, $\forall x, y \in R$, then the value of $f(9)-f(3)$ is equal to

(1) 5

(2) 4

(3) 6

(4) 7

Q14

The sequence a_n is defined by $a_1 = \frac{1}{2}, a_{n+1} = a_n^2 + a_n$. Also, $s = \frac{1}{a_1+1} + \frac{1}{a_2+1} + \ldots + \frac{1}{a_{100}+1}$ then $[S]$

(where [.] denotes the greatest integer function) is

(1) 1

(2) 2

(3) 3

(4) 4

Q15

A square matrix P satisfies $P^2 = I - 2P$ where I is the identity matrix if $P^2 + P^3 + P^4 = a^2 I - b^2 P$ then

mark incorrect option

(1) $a^2 + b^4$ is a perfect square

(2) $a^4 + b^2$ is a perfect square

(3) $a^2 + b^2$ is prime

(4) $a^4 + b^4$ is prime

Q16

Let k be the coefficient of x^{18} in the polynomial

$f(x) = (1+x)^{20} + x(1+x)^{19} + x^2(1+x)^{18} + \ldots + x^{18}(1+x)^2$ then the value of $\frac{k}{190}$ is equal to

_____.

(1) 8

(2) 7

(3) 6

(4) 5

Q17

Let $f : (0, \infty) \to R$ be a differentiable function satisfying $f(x) + e^{f(x)} = \frac{2}{x} - \ln x - 1$. Find the number of integers in the range of x satisfying the inequality $f\left(2x^2 + 1\right) - f\left(x^2 + 5\right) \geq f(1), x > 0$.

(1) 5

(2) 3

(3) 2

(4) 1

Q18

If a, b and c are real numbers such that $a^2 + b^2 + c^2 - ab - bc - ac \leq 0$, then

$$\begin{vmatrix} (a - b + 1)^5 & b^7 - c^7 & c^9 - a^9 \\ a^{11} - b^{11} & (b - c + 2)^3 & c^{13} - a^{13} \\ a^{15} - b^{15} & b^{17} - c^{17} & (c - a + 3)^1 \end{vmatrix} =$$

(1) $2abc$

(2) 0

(3) $24abc$

(4) 24

Q19

The locus of the point (x, y) whose distance from the line $y = 2x + 2$ is equal to the distance from $(2, 0)$, is a parabola with the length of latus rectum same as that of the parabola $y = Kx^2$, then the value of K is equal to

(1) $\frac{\sqrt{5}}{12}$

(2) $\frac{\sqrt{5}}{4}$

(3) $\frac{4}{\sqrt{5}}$

(4) $\frac{12}{\sqrt{5}}$

Q20

The value of the expression

$$\tan\left(\tan^{-1}\left(\tfrac{1}{2}\right) + \tan^{-1}\left(\tfrac{2}{9}\right) + \tan^{-1}\left(\tfrac{1}{8}\right) + \tan^{-1}\left(\tfrac{2}{25}\right) + \tan^{-1}\left(\tfrac{1}{18}\right) + \ldots\ldots\infty\right),\ \text{is:}$$

(1) 2

(2) 3

(3) 4

(4) 5

Q21

The shortest distance between the following pair of lines: $\vec{r} = \hat{i} + 2\hat{j} - 4\hat{k} + \lambda\left(2\hat{i} + 3\hat{j} + 6\hat{k}\right)$ and $\vec{r} = 3\hat{i} + 3\hat{j} - 5\hat{k} + \mu\left(2\hat{i} + 3\hat{j} + 6\hat{k}\right)$ is $\dfrac{\sqrt{293}}{K}$. Find the value of K.

Q22

For some function $f(x)$ and $g(x)$ which are differentiable $\forall x > 0$ satisfy the following condition.

(i) $\left(\dfrac{f(x)}{x}\right)' = x^2 e^{-x^2}$

(ii) $g(x) = \dfrac{4}{e^4}\int_1^x e^{t^2} \cdot f(t)dt$

(iii) $f(1) = \dfrac{1}{e}$

Find the value of $3e^4(f(2) - g(2))$.

Q23

If $x\,dy = y(\,dx + y\,dy), y(1) = 1, y(x) > 0$, then $y(-3)$ is

Q24

Let $f : A \to B$ be any function where A is a set containing the positive integral solution of the inequality $\operatorname{cosec}^{-1}(\operatorname{cosec} 2) > x^2 - 3x$ and B is the set of all divisors of the natural number 2010. If $f(i) \le f(j)\ \forall\ i < j$, then find the total number of mappings from A to B.

Q25

Let e the eccentricity of a hyperbola and $f(e)$ be the eccentricity of its conjugate hyperbola. If n is an even positive integer, then $\int_1^3 \underbrace{fofofo....of}_{n \text{ times}} (e)$ is equal to 'a' then 2 a equal to

Q26

A certain liquid has a melting point of $-50°C$ and a boiling point of $150°C$. A thermometer is designed with this liquid and its melting and boiling points are designated at $0°L$ and $100°L$. The melting and boiling points of water on this scale are

(1) $25°L$ and $75°L$, respectively

(2) $0°L$ and $100°L$, respectively

(3) $20°L$ and $70°L$, respectively

(4) $30°L$ and $80°L$, respectively

Q27

There are three persons A, B & C moving with constant velocity. Speed of A is 10 m/sec towards east, velocity of B relative to A is 6 m/sec at an angle of $\cos^{-1}\left(\frac{15}{24}\right)$ north of east. The velocity of C relative to B is 12 m/sec towards west. What will be the magnitude of velocity of C in m/sec ?

(1) 3

(2) 5

(3) 2

(4) 4

Q28

For the given circuit, the input digital signals are applied at the terminals A, B and C. What would be the output at the terminal y ?

(1)

(2)

(3)

(4)
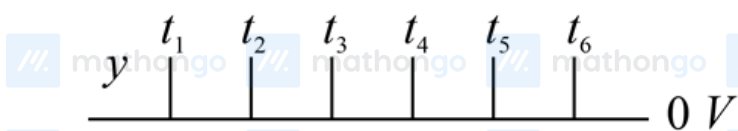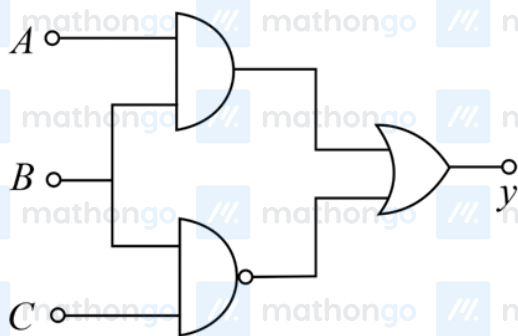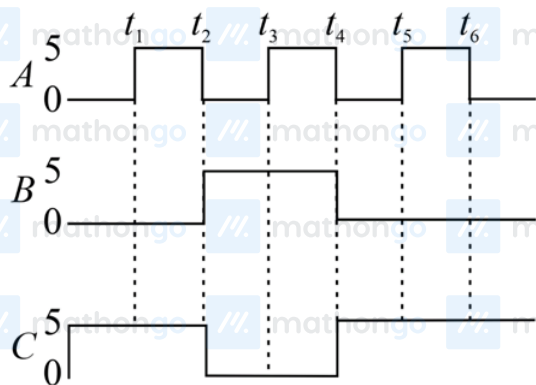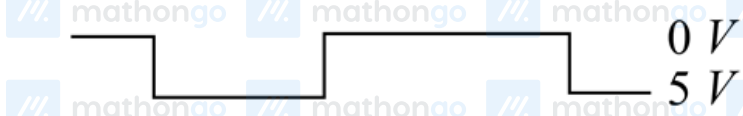
Q29

In Young's double slit experiment, the separation between two slits is 0.3×10^{-3} m. When light beam is passed through the two slits, then interference pattern is observed on the screen 1.5 m away. If the first violet and red fringes are formed 2.0 mm and 3.5 mm away from the central white fringe, then the difference in wavelength of red and violet light is $x \times 10^{-9}$ m. The value of x is

(1) 100

(2) 300

(3) 400

(4) 500

Q30

Two moles of an ideal gas have undergone a cyclic process $1 - 2 - 3 - 1$. If net heat exchange in the process is -300 J, then work done by the gas in the process $2 - 3$ is $\left(R = 8.3 \ J \ mol^{-1} \ K^{-1} \right)$
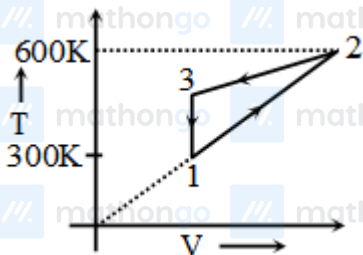
(1) 5280J

(2) -4680J

(3) 4680J

(4) -5280J

Q31

A current i is uniformly distributed over the cross-section of a long hollow cylindrical wire of inner radius R_1 and outer radius R_2. Magnetic field B varies with distance from the axis of the cylinder as

(1)

(2)

(3)

(4)
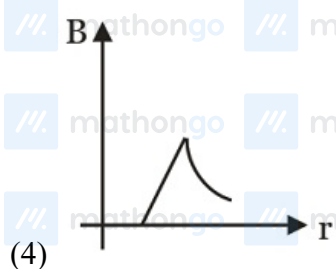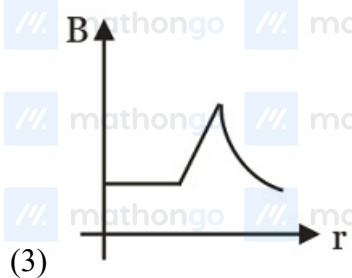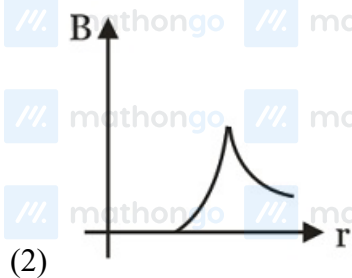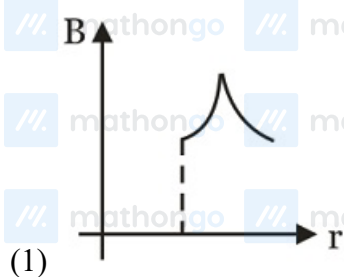
Q32

Assertion- The red light is just able to emit photoelectrons from a metal surface, then violet light cannot emit the photoelectrons from that metal.

Reason- The energy of violet light photons is more than red light photons.

(1) Both Assertion and Reason are true but Reason is not correct explanation of Assertion.

(2) Assertion is true but Reason is false.

(3) Assertion is false but Reason is true.

(4) Both Assertion and Reason are false.

Q33

An arrangement of rods each of mass m and length l are welded (whereever required) to form a shape as shown. The moment of inertia about an axis passing through point C and perpendicular to the plane of figure is:
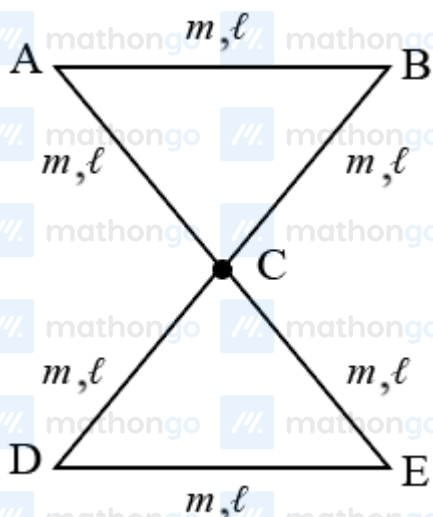
(1) ml^2

(2) $\frac{3}{2}ml^2$

(3) $3ml^2$

(4) $\frac{9}{2}ml^2$

Q34

As shown in figure, a point charge $+20 \ \mu C$ is placed 6 cm vertically above the center of a square of side 12 cm. As a result of this arrangement, the electric flux through the square will be
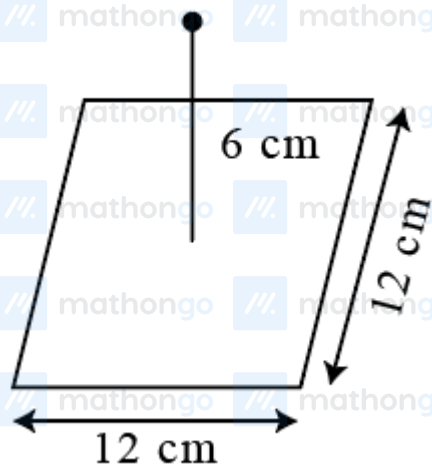
(1) 2.5×10^6 N m^2 C^{-1}

(2) 3.8×10^5 N m^2 C^{-1}

(3) 4.2×10^5 N m^2 C^{-1}

(4) 2.9×10^6 N m^2 C^{-1}

Q35

Assertion: The loop shown in the diagram will have tendency to expand.

(Magnetic field is directed downward)
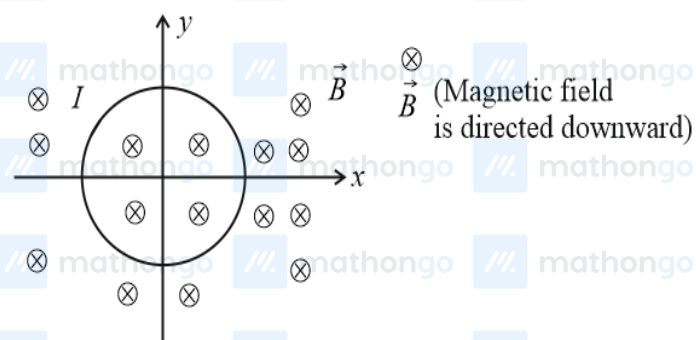
Reason: Net force acting on a closed loop in external uniform magnetic field is zero.

(1) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

(2) If both Assertion and Reason are true but Reason is not correct explanation of the Assertion.

(3) If Assertion is true but the Reason is false.

(4) If Assertion is false but Reason is true.

Q36

The wavelength of a spectral line emitted by hydrogen atom in the Balmer series is $\frac{16}{3R}$ (R is Rydberg constant). What is the value of the principal quantum number of the state from which the transition takes place?

(1) 5

(2) 6

(3) 3

(4) 4

Q37

For the angle of minimum deviation of a prism to be equal to its refracting angle, the prism must be made of a material whose refractive index:

(1) lies between $\sqrt{2}$ and 1

(2) lies between 2 and $\sqrt{2}$

(3) is less than 1

(4) is greater than 2

Q38

A small conducting sphere of the radius r is lying concentrically inside a bigger hollow conducting sphere of radius R. The bigger and smaller sphere are charged with Q and $q(\ Q > q)$ and are insulated from each other. The potential difference between the sphere will be

(1) $\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r} - \frac{q}{R}\right)$

(2) $\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{R} - \frac{Q}{r}\right)$

(3) $\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r} - \frac{Q}{R}\right)$

(4) $\frac{1}{4\pi\varepsilon_0}\left(\frac{Q}{R} + \frac{q}{r}\right)$

Q39

Frequencies of various radiations are given as

$f_v \rightarrow$ Visible light

$f_r \rightarrow$ Radio waves

$f_{uv} \rightarrow$ Ultra Violet waves

Then which of the following is true?

(1) $f_{uv} < f_v < f_r$

(2) $f_r < f_v < f_{uv}$

(3) $f_v < f_r < f_{uv}$

(4) $f_{uv} < f_r < f_v$

Q40

A gas satisfies the relation $PV^{5/3} = K$ where P is pressure, V is volume and K is constant. The dimensions of constant K are

(1) $\text{ML}^4\,\text{T}^{-2}$

(2) $\text{ML}^2\,\text{T}^{-2}$

(3) $\text{ML}^6\,\text{T}^{-2}$

(4) MLT^{-2}

Q41

A cylindrical metallic rod in thermal contact with two reservoirs of heat at its two ends conducts an amount of heat Q in time t. The metallic rod is melted and the material is formed into a rod of half the radius of the original rod. What is the amount of heat conducted by the new rod, when placed in thermal contact with the two reservoirs in time t?

(1) $\frac{Q}{4}$

(2) $\frac{Q}{16}$

(3) $2Q$

(4) $\frac{Q}{2}$

Q42

A ring was initially at rest on a rough floor and a force F (parallel to floor) is applied on the top of the rolling body. Choose the correct option for the pure accelerated rolling.
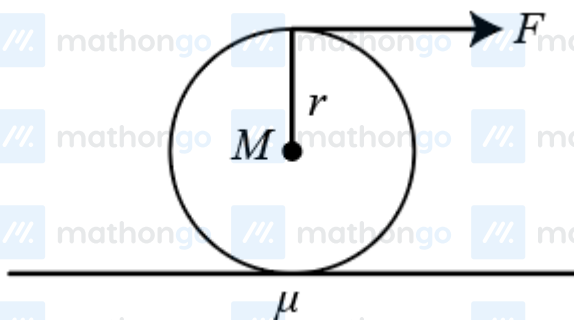
(1) The kinetic friction (f_k) will act in opposite direction of force

(2) The static friction must act

(3) The friction will not act in the backward direction

(4) If rolling body is a disc, the static friction will act in the backward direction

Q43

A student writes down four conclusions that he observes while performing a polarization experiment with 3 polarisers as shown in the figure. The leftmost and the rightmost polariser are fixed and crossed and the middle one can be rotated. The intensity of the unpolarised light is I_0. Identify the incorrect conclusion noted by him.
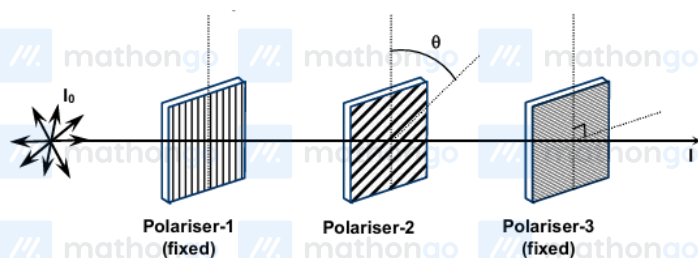
(1) If $\theta = 0°$ then $I = 0$

(2) If $\theta = 90°$ then $I = 0$

(3) If $\theta = 45°$ then $I = \frac{I_0}{8}$

(4) If $\theta = 30°$ then $I = \frac{3I_0}{16}$

Q44

Assertion : lt is not possible for a system, unaided by an external agency to transfer heat from a body at lower temperature to another body at higher temperature.

Reason : According to Clausius statement, " No process is possible whose sole result is the transfer of heat from a cooled object to a hotter object.

(1) If both assertion and reason are true and the reason is the correct explanation of the assertion.

(2) If both assertion and reason are true but reason is not the correct explanation of the assertion.

(3) If assertion is true but reason is false.

(4) If the assertion and reason both are false.

Q45

A ball of mass 100 gm and carrying charge 1 C is released from a point near the surface of earth, in a uniform horizontal magnetic field of 2T. Find the maximum speed attained by the ball in m/s. (Take $g = 10$ m/s^2, assume ball attains maximum speed before hitting ground)

(1) 1.5 m/s

(2) 1 m/s

(3) 2 m/s

(4) 0.5 m/s

Q46

An equiconvex lens made of glass of refractive index $\frac{3}{2}$ has focal length f in air. It is completely immersed in water of refractive index $\frac{4}{3}$. The percentage change in the focal length is

Q47

The rear side of a truck is open and a box of 40 kg mass is placed 5 m away from the open end as shown. The coefficient of friction between the box & the surface below it is 0.15. On a straight road, the truck starts from rest and accelerates with 2 ms^{-2} At what distance (in m.) from the starting point does the box fall off the truck

(i.e. distance travelled by the truck)? [Ignore the size of the box] [value of $g = 10m/s^2$]
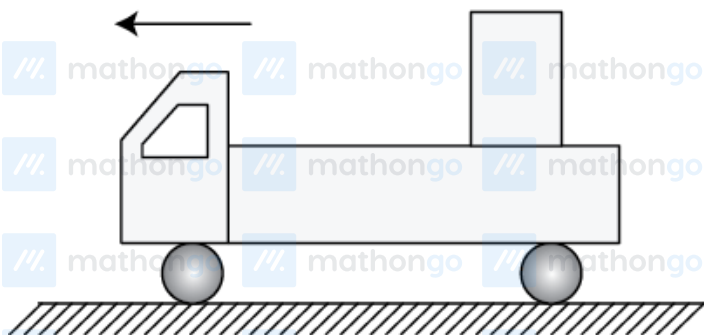
Q48

A ball falling in a lake of 200 m shows a decrease of 0.1 % in its volume. The Bulk modulus of elasticity of the material of the ball is _____ $\times 10^9 \text{N/m}^2$. (take g $= 10 \text{ m s}^{-2}$)

Q49

An ideal choke takes a current of 10amp when connected to an AC supply of 125 volt and 50 Hz. A pure resistor under the same conditions takes a current of 12.5amp. If the two are connected to an AC supply $100\sqrt{2}$ volt and 40 Hz, then find the current in series combination of above resistor and inductor. If it is $5 \times$ n Amp. Find value of n

Q50

The escape velocity from a planet is v_0. The escape velocity from a planet having twice the radius but same density is nv_0 then n is:

Q51

Which of the following statements are correct?

1. Electron density in xy plane in $3d_{x^2-y^2}$ orbital is zero.

2. Electron density in xy plane in $3d_{z^2}$ orbital is zero.

3. 2s orbital has only one spherical node in it.

4. For $2p_x$ orbital yz is the nodal plane.

(1) 3 and 4

(2) All of these

(3) 2

(4) 1 and 3

Q52

Which of the following does not represent property stated against it?

(1) $Co^{2+} < Fe^{2+} < Mn^{2+}$ - Ionic size

(2) $Ti < V < Mn-$ Number of oxidation states

(3) $Cr^{2+} < Mn^{2+} < Fe^{2+}$ - Paramagnetic behaviour

(4) $Sc < Cr < Fe$ - Density

Q53

Which of the following pairs have different hybridisation and same shape?

(i) NO_3^- and CO_3^{2-}

(ii) SO_2 and NH_2^-

(iii) XeF_2 and CO_2

(iv) H_2O and NH_3

(1) (i) and (iv)

(2) (ii) and (iv)

(3) (ii) and (iii)

(4) None of these

Q54

What will be the correct structural formula of the final product for the following reaction?

$$A \xrightarrow{HIO_4} B \xrightarrow[\triangle]{OH^-} C$$

(1)

(2)

(3)

(4)

Q55
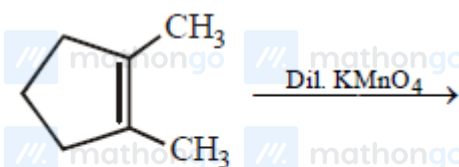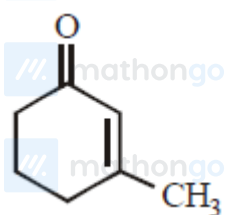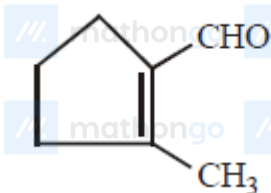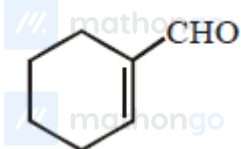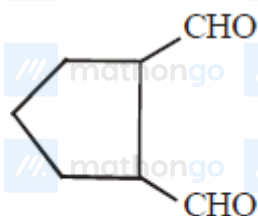
Amongst the following statements

I : The structure of $[BrF_4]^+$ is regular tetrahedral

II: Bond order of O_2 decreases by the removal of an electron

III : Br_3^- and Br_3^+ are having same shape and same structure

IV : The hybrid orbital of phosphorous in PCl_5 is $sp^3 d_{xy}$

The incorrect statements is/are

(1) only II

(2) I, III, IV

(3) I, II, III

(4) I, II, III, IV

Q56

Which order for basic character of amine is correct for following compounds?
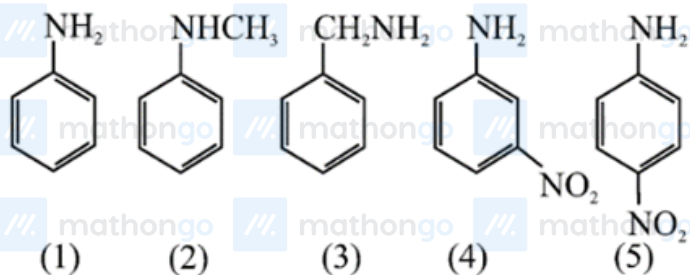
(1) $3 > 1 > 2 > 5 > 4$

(2) $3 > 2 > 1 > 5 > 4$

(3) $3 > 1 > 2 > 4 > 5$

(4) $3 > 2 > 1 > 4 > 5$

Q57

The $E_{M^{3+}/M^{2+}}$ values for Cr, Mn, Fe and Co are –0.41, +1.57, +0.77 and +1.97 V respectively. For which one of these metals the change in oxidation state form +2 to +3 is easiest?

(1) Cr

(2) Mn

(3) Fe

(4) Co

Q58

For the reaction $R \rightleftharpoons P$, variation of concentration is plotted against time. The time at which the equilibrium establishes is as shown:
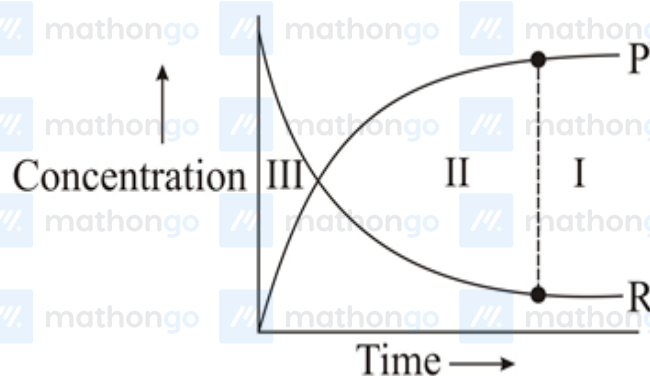
Which of the following regions show(s) equilibrium?

(1) III

(2) II

(3) I

(4) Both II and III

Q59

Prussian blue is a deep blue pigment containing Fe^{2+}, Fe^{3+} and CN^- ions. It has the formula $Fe_7(CN)_{18}$. How many Fe^{2+} and Fe^{3+} ions are there per formula unit?

(1) $3Fe^{2+}$ and $4Fe^{3+}$

(2) $4Fe^{2+}$ and $3Fe^{3+}$

(3) $5Fe^{2+}$ and $2Fe^{3+}$

(4) $6Fe^{2+}$ and $1Fe^{3+}$

Q60

An organic compound contains 49.3% carbon, 6.84% hydrogen and its vapour density is 73 . Molecular formula of the compound is :

(1) $C_3H_5O_2$

(2) $C_4H_{10}O_2$

(3) $C_6H_{10}O_4$

(4) $C_3H_{10}O_2$
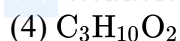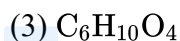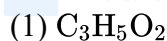
Q61

Wavelength of red light is absorbed by the complex

(1) $\left[Cu(CN)_4\right]^{2-}$

(2) $\left[Cu(NH_3)_4\right]^{2+}$

(3) $CuSO_4$

(4) $Cu(CN)_2$.
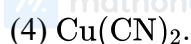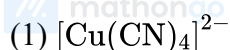
Q62

Assertion : Molecular nitrogen is less reactive than molecular oxygen.

Reason : The bond length of N_2 is shorter than that of oxygen.

(1) If both assertion and reason are true and reason is the correct explanation of assertion.

(2) Ifboth assertion and reason are true but reason is not the correct explanation of assertion.

(3) If assertion is true but reason is false.

(4) If both assertion and reason are false.

Q63

Which of the following is/are correct for the first order reaction? (a is initial concentration of reactant, x is concentration of the reactant reacted and t is time)

(I) (II) (III)
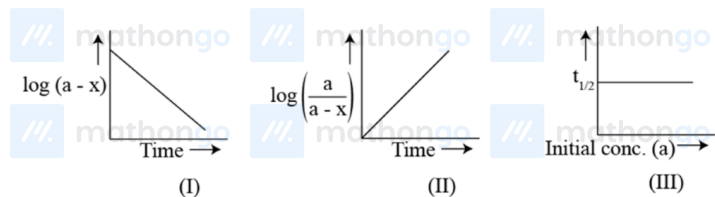
(1) I and II only

(2) II and III only

(3) I, II and III only

(4) I and III only

Q64

Which of the following reaction is used to produce aldehyde?

(1) $CH_3CH_2COOH \xrightarrow[\text{ii) } H_3O^+]{\text{i) } LiAlH_4/\text{ ether}}$

(2) $CH_3COCl \xrightarrow{R_2CuLi}$

(3) $CH_3COOH \text{ (vapours)} \xrightarrow[\Delta]{MnO}$

(4) $CH_3CN \xrightarrow[\text{ii) } H_3O^+]{\text{i) } SnCl_2/HCl}$
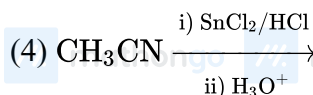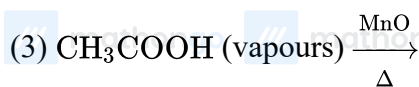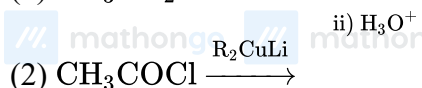
Q65

K_a for HCN is 5×10^{-10} at $25°C$. For maintaining a constant pH of 9, the volume of 5 M KCN solution required to be added to 10 mL of 2 M HCN solution is

(1) 4 mL

(2) 8 mL

(3) 2 mL

(4) 9 mL

Q66

Assertion : ionization potential across the period is $Na < Al < Mg < Si$.

Reason : ionization potential decreases with decrease in atomic size.

(1) If both assertion and reason are true and the reason is the correct explanation of the assertion.

(2) If both assertion and reason are true but reason is not the correct explanation of the assertion.

(3) If assertion is true but reason is false.

(4) If the assertion and reason both are false.

Q67

The major product P of the following reaction is

(1)

(2)

(3)

(4)

Q68

$(A) C_2H_5NH_2 \xrightarrow[\text{(ii) AgNO}_2]{\text{(i) NOCl}} \left[W \right]$

$(B) (CH_3)_2CHNH_2 \xrightarrow[\text{(ii) AgNO}_2]{\text{(i) NOCl}} \left[X \right]$

$(C) (CH_3)_3CNH_2 \xrightarrow[\text{(ii) AgNO}_2]{\text{(i) NOCl}} \left[Y \right]$

$(D) CH_3CH(NH_2)C_2H_5 \xrightarrow[\text{(ii) AgNO}_2]{\text{(i) NOCl}} \left[Z \right]$

Which product will not show tautomerism?

(1) W

(2) X

(3) Y

(4) Z

Q69

Compare vitamin **List I** with its deficiency disease **List II.**

	Column-I		Column-II
(A)	Vitamin - B_{12}	(1)	Sterility
(B)	Vitamin - B_6	(2)	Haemorrhagic condition
(C)	Vitamin - E	(3)	Pernicious anaemic
(D)	Vitamin - K	(4)	Skin diseases

Codes :

(1)

A	B	C	D
1	2	3	4

	A	B	C	D
(2)	2	3	4	1
(3)	3	4	1	2
(4)	3	4	2	1

Q70

The enthalpies of formation of N_2O and NO are 28 and 90 kJ mol^{-1} respectively. The enthalpy of the reaction $2N_2O(g) + O_2(g) \to 4NO(g)$ is equal to

(1) 8 kJ

(2) 88 kJ

(3) -16 kJ

(4) 304 kJ

Q71

In Carius method for estimation of halogens, 0.2 g of an organic compound gave 0.188 g of AgBr. The percentage of bromine in the compound is _____. (Nearest integer)

[Atomic mass: $Ag = 108, \ Br = 80$]

Q72

Ethylene glycol is used as an antifreeze in cold climate. Mass of ethylene glycol which should be added to 4 kg of water to prevent it from freezing at -6° C will be ..... g. $\left(K_f \text{ for water} = 1.86 \text{ K kg mol}^{-1} \text{ and molar mass of ethylene glycol} = 62 \text{ g mol}^{-1}\right)$

Q73

For the two parallel reaction $A \xrightarrow{k_1 = 2 \sec^{-1}} B$ and $A \xrightarrow{k_2 = 4 \sec^{-1}} C$, the activation energy E' for the disappearance of A is given in terms of activation energies E_1 and E_2 for the two path by $E' = \frac{E_1 + 2E_2}{x}$. The value of x is _____.

Q74

Identify the major product formed from the following

$$CH_3 - CH = CH_2 \xrightarrow[\begin{array}{l}\text{(iii) Cu/573 K} \\ \text{(iv) Ba(OH)}_2, \Delta\end{array}]{\begin{array}{l}\text{(i) HBr} \\ \text{(ii) NaOH}\end{array}}$$
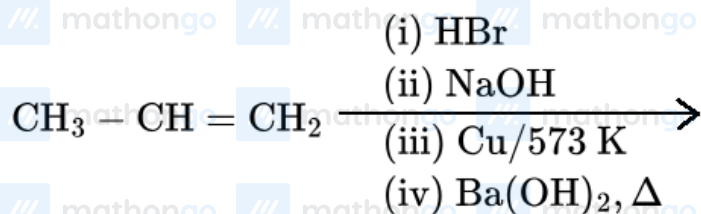
How many carbon - hydrogen bond pairs are there in final product?

Q75

V_1 mL of NaOH of molarity X and V_2 mL of $Ba(OH)_2$ of molarity Y are mixed together. The mixture is completely neutralized by 100 mL of 0.1 N HCl. If $V_1/V_2 = 1/4$ and $X/Y = 4$ then the fraction of acid is neutralized by $Ba(OH)_2$ is K, find 3K. (nearest integer).

Answer Key

Q1 (3) **Q2** (1) **Q3** (1) **Q4** (3)

Q5 (4) **Q6** (2) **Q7** (3) **Q8** (1)

Q9 (4) **Q10** (1) **Q11** (2) **Q12** (2)

Q13 (3) **Q14** (1) **Q15** (1) **Q16** (2)

Q17 (3) **Q18** (4) **Q19** (1) **Q20** (2)

Q21 (7) **Q22** (20) **Q23** (3) **Q24** (816)

Q25 (8) **Q26** (1) **Q27** (2) **Q28** (3)

Q29 (2) **Q30** (4) **Q31** (2) **Q32** (3)

Q33 (3) **Q34** (2) **Q35** (2) **Q36** (4)

Q37 (2) **Q38** (1) **Q39** (2) **Q40** (1)

Q41 (2) **Q42** (3) **Q43** (4) **Q44** (1)

Q45 (2) **Q46** (300) **Q47** (20) **Q48** (2)

Q49 (2) **Q50** (2) **Q51** (1) **Q52** (3)

Q53 (3) **Q54** (1) **Q55** (4) **Q56** (4)

Q57 (1) **Q58** (3) **Q59** (1) **Q60** (3)

Q61 (2) **Q62** (1) **Q63** (3) **Q64** (4)

Q65 (3) **Q66** (3) **Q67** (1) **Q68** (3)

Q69 (3)   **Q70** (4)   **Q71** (40)   **Q72** (800)

Q73 (3)   **Q74** (10)   **Q75** (2)

Q1

Vowels = E, U, I, O, A

Consonants = Q, T, N
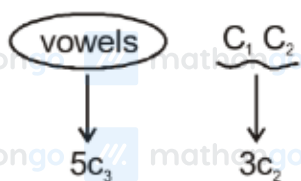
N. O. W = $5c_3 \cdot {}^3c_2 \lfloor 3 \rfloor \lfloor 3 \rfloor$

selection of vowels   selection of consonants   Inter Permutation   Intra permutation

$= 10 \times 3 \times 6 \times 6 = 1080$

Q2

$x - 2y + bz = 3$
$ax + 2z = 2$
$5x + 2y = 1$

$$\Delta = \begin{vmatrix} 1 & -2 & b \\ a & 0 & 2 \\ 5 & 2 & 0 \end{vmatrix} = -24 + 2ab$$

$$\Delta_1 = \begin{vmatrix} 1 & -2 & 3 \\ a & 0 & 2 \\ 5 & 2 & 1 \end{vmatrix}$$

$\Delta_1 = 8a - 24$

$$\Delta_2 = \begin{vmatrix} 1 & 3 & b \\ a & 2 & 2 \\ 5 & 1 & 0 \end{vmatrix}$$

$\Delta_2 = 28 + ab - 10b.$

$$\Delta_3 = \begin{vmatrix} 3 & -2 & b \\ 2 & 0 & 2 \\ 1 & 2 & 0 \end{vmatrix}$$

$\Delta_3 = 16 + 4b.$

$ab = 12 \Rightarrow \Delta = 0$

$a \neq 3 \Rightarrow \Delta_1 \neq 0$

Hence no solution

Q3

Given,

$S = \{1, 2, 3, \ldots \ldots 10\}$

$P(S) =$ power set of S

$AR_1B \Rightarrow (A \cap B^c) \cup (A^c \cap B) = \phi$

Now for reflexive property, replacing B with A we get,

$(A \cap A^c) \cup (A^c \cap A)$ which ϕ always,

Now checking symmetric we will interchange A & B,

So, $(B \cap A^c) \cup (B^c \cap A)$ which is same as $(A \cap B^c) \cup (A^c \cap B)$, hence the relation is symmetric,

So, R_1 is reflexive, symmetric

Now checking for transitive

$(A \cap B^c) \cup (A^c \cap B) = \phi$;

Now from diagram the elements in $(A \cap B^c) \cup (A^c \cap B)$ will be,

$\{a\} \cup \{b\}$ which is given as empty set ϕ

Hence, we can say that, $\{a\} = \phi = \{b\} \Rightarrow A = B$

Now taking, $(B \cap C^c) \cup (B^c \cap C) = \phi \therefore B = C$

$\therefore \quad A = C$ equivalence.

Now solving,

$$R_2 \equiv A \cup B^c = A^c \cup B$$

Now for reflexive replacing $B \to A$ we get,

$A \cup A^c = A^c \cup A$ which is true,

And for symmetric interchanging $A \Leftrightarrow B$ we get,

$B \cup A^c = B^c \cup A$ which is again true,

Hence, $R_2 \to$ Reflexive, symmetric

Now for transitive,

From diagram the elements in $A \cup B^c = A^c \cup B \Rightarrow \{a, c, d\} = \{b, c, d\}$

On comparing both side, we get $\{a\} = \{b\}$ $\therefore$ $A = B$

And, $B \cup C^c = B^c \cup C \Rightarrow B = C$

$\therefore$ $A = C$ $\therefore$ $A \cup C^c = A^c \cup C$

$\therefore$ Equivalence

Hence, both given relation are equivalence.

Q4
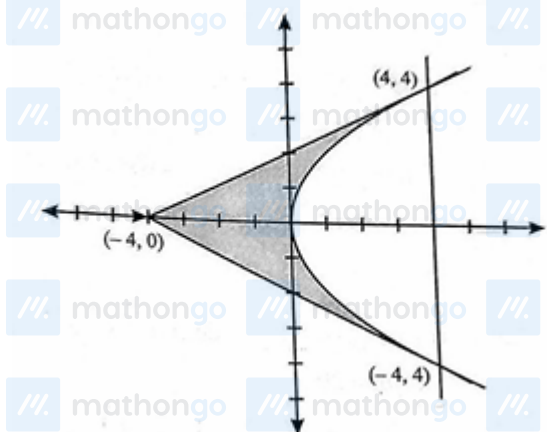
Area of the shaded region is

$$= \frac{1}{2} \times 8 \times 8 - \frac{2}{3} \times 32$$
$$= \frac{1}{3} \times 32$$
$$\Rightarrow \frac{32}{3} = \Delta$$
$$\therefore [\Delta] = 10$$

Q5

Ellipse: $\frac{x^2}{45} + \frac{y^2}{20} = 1$

Foci: $(\pm 5, \, 0)$

Let's say $\theta = \cos^{-1}\left(\frac{-1}{\sqrt{5}}\right) \Rightarrow \cos\theta = \frac{-1}{\sqrt{5}} \Rightarrow \tan\theta = -2$

Now, equation of line passing through $(-5, \ 0)$ and of slope -2 can be written as $y = -2(x+5)$ or

$y = -2x - 10$

Now, if we solve this line with given ellipse equation

$\frac{x^2}{45} + \frac{(-2x-10)^2}{20} = 1$

This gives us point of intersection above x-axis at $(-6, \ 2)$. (Point $(-3, 4)$ will be rejected as slope of line

joining it with focus will be 2 but slope of line given is -2).

Now, since line meets the ellipse above x-axis at $(-6, \ 2)$. Therefore, it is also the point from where ray got

reflected.

From reflection property of ellipse, we can say that reflected ray passes through the other focus whose

coordinates are $(5, \ 0)$.

Hence, slope $= \frac{2-0}{-6-5} = -\frac{2}{11}$

Q6

$-3 < \alpha < \frac{21}{5}$

Q7
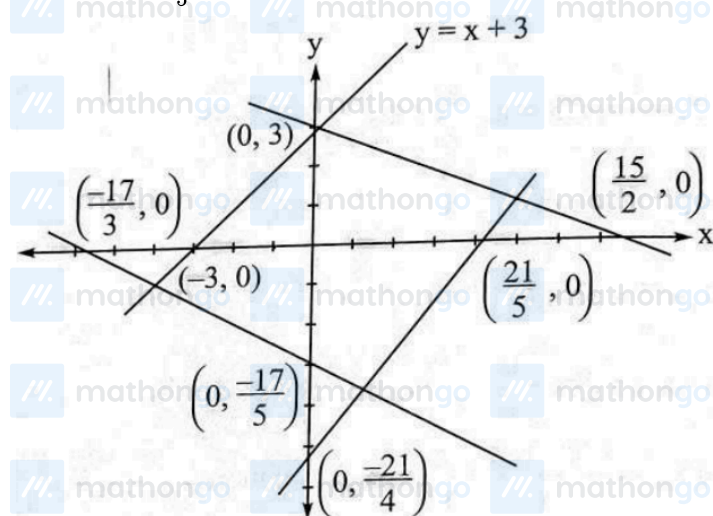
$(\vec{c} - \vec{a}) \cdot (\vec{b} - \vec{c}) = 0 \Rightarrow \overrightarrow{AC} \cdot \overrightarrow{CB} = 0 \Rightarrow \Delta ABC$ is right angle at C

B($\vec{b}$)

k+2

k

C($\vec{c}$)   k+1   A($\vec{a}$)
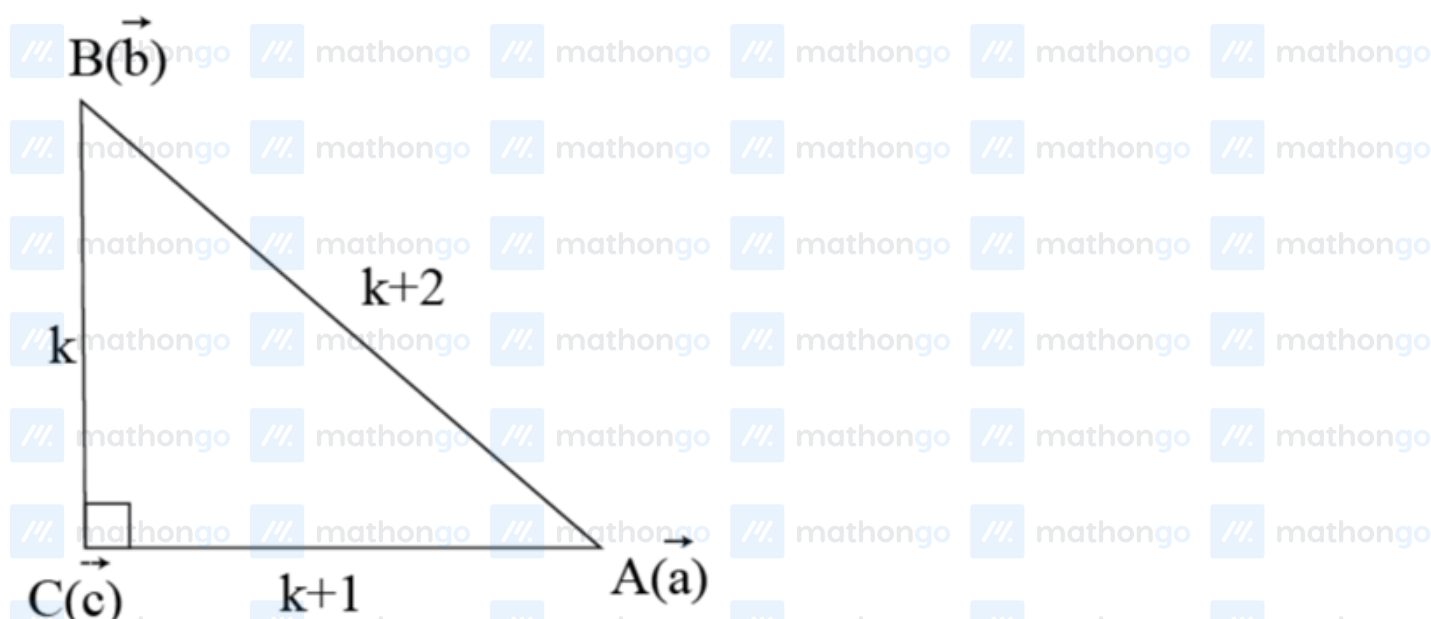
From diagram $k^2 + (k+1)^2 = (k+2)^2$

$k^2 + k^2 + 2k + 1 = k^2 + 4k + 4$

$k^2 - 2k - 3 = 0 \Rightarrow k = 3, -1 (\because k \neq -1)$

So, sides are $3, 4, 5$

Area of $\Delta ABC = \frac{1}{2}|\vec{a} \times \vec{b} + \vec{b} \times \vec{c} + \vec{c} \times \vec{a}| = \frac{1}{2} \times 3 \times 4$

$\Rightarrow |\vec{a} \times \vec{b} + \vec{b} \times \vec{c} + \vec{c} \times \vec{a}| = 12$

Q8

$x dy - y \log_e y dx + x^2 y \left(2x \sin x + x^2 \cos x\right) dx = 0$

$\dfrac{x dy - y \log_e y dx}{yx^2} + \left(2x \sin x + x^2 \cos x\right) dx = 0$

$\displaystyle\int d\left(x^2 \sin x\right) + \int d\left(\dfrac{\log_c y}{x}\right) = 0 + c$

$x^2 \sin x + \dfrac{\log_e y}{x} = c$

$\dfrac{\log_e y}{x} = c - x^2 \sin x$

$\log_e y = x\left(c - x^2 \sin x\right)$

$y = e^{x\left(c - x^2 \sin x\right)}$

Q9

$13, a_1, a_2, a_3, \ldots . a_{20}, 67$ are in AP.

$\therefore \quad a_1 + a_2 + a_3 + \ldots + a_{20} = 20 \left(\frac{13+67}{2} \right) = 800$

Now, $\qquad \mathrm{AM} \geq \mathrm{GM}$

$\therefore \quad \frac{a_1 + a_2 + a_3 + \ldots a_{20}}{20} \geq (a_1 a_2 a_3 \ldots a_{20})^{\frac{1}{20}}$

$\Rightarrow \left(\frac{800}{20} \right) \geq (a_1 a_2 a_3 \ldots a_{20})^{\frac{1}{20}}$

or, $\quad a_1 a_2 a_3 \ldots a_{20} \leq (40)^{20}$

$\therefore$ The maximum value of $a_1 \cdot a_2 \cdot a_3 \cdot \ldots . a_{20}$ is $(40)^{20}$.

Q10

We are given the function:

$$f(x) = \max(\sin x, 2x) + \lfloor \max(\sin x, 2x) \rfloor$$

where $\lfloor \cdot \rfloor$ denotes the greatest integer function. We need to determine the number of points of non-differentiability of $f(x)$ in the interval $(0, 2\pi)$.

The function $\max(\sin x, 2x)$ can be non-differentiable at points where:

1. The two expressions inside the max function are equal, i.e.,

$\sin x = 2x$

Solving this numerically in $(0, 2\pi)$, we find 6 points where this happens.

2. The floor function introduces discontinuities, which occur when $\max(\sin x, 2x)$ takes integer values. Since the greatest integer function is discontinuous at integer points, we solve for:

$\max(\sin x, 2x) \in \mathbb{Z}$

Within the given interval, this results in 6 more points.

Thus, the total number of points of non-differentiability is:

$6 + 6 = 12$

Q11

Three fair coins numbered 1,0 are tossed.

$\therefore$ Sample space $= \{111, 110, 101, 011, 100, 010, 001, 000\}$

$\therefore \text{n(S)} = 8$

X represents the sum of numbers on upper most face

$\therefore P(X = 0) = \dfrac{1}{8},$
$P(X = 1) = \dfrac{3}{8},$
$P(X = 2) = \dfrac{3}{8},$
$P(X = 3) = \dfrac{1}{8}$

$\therefore$ Probability distribution of X is

X	0	1	2	3
P(X)	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{8}$

$$E(X) = \sum_{x=0}^{3} x_i P(x_i)$$

$$E(X) = 0 \times \frac{1}{8} + 1 \times \frac{3}{8} + 2 \times \frac{3}{8} + 3 \times \frac{1}{8}$$

$$= \frac{12}{8} = \frac{3}{2}$$

$$E\left(X^2\right) = \sum_{x=0}^{3} x_1^2 P(x_i) = 3$$

Variance of $X = E\left(X^2\right) - [E(X)]^2$

$$= 3 - \left(\frac{3}{2}\right)^2$$

$$= 3 - \frac{9}{4}$$

$$= \frac{3}{4} = 0.75$$

Q12

$$\vec{a} \cdot \vec{b} = x + y + z = 0$$

If $x = 3, y = -3, z = 0$, i.e. $3! = 6$

If $x = 6, y = -6, z = 0$, i.e. $3! = 6$

If $x = 6, y = -3, z = -3$, i.e. $\frac{3!}{2!} = 3$

If $x = -6, y = 3, z = 3$, i.e. $= \frac{3!}{2!} = 3$

Total number of vectors $= 18$

Q13

Let $f(x) = a_0 x^n + a_1 x^{n-1} + a_2 x^{n-2} + \ldots a_n$

Putting in given equation and comparing

Coefficients of powers of x,

We get $f(x) = x + b$. Where b is constant

$\therefore \quad f(9) - f(3) = 6$

Q14

$$\frac{1}{a_{n+1}} = \frac{1}{a_n(a_n+1)} = \frac{1}{a_n} - \frac{1}{a_{n+1}}$$

$$\Rightarrow S = \frac{1}{a_1} - \frac{1}{a_2} + \ldots + \frac{1}{a_{100}} - \frac{1}{a_{101}}$$

$$= \frac{1}{a_1} - \frac{1}{a_{101}} = 2 - \frac{1}{a_{101}}$$

Since, $a_{101} > 1 \Rightarrow [S] = 1$

Q15

$$P^2 = I - 2P$$
$$P^3 = P - 2P^2 = P - 2(I - 2P)$$
$$= P - 2I + 4P$$
$$P^3 = 5P - 2I$$
$$P^4 = 5P^2 - 2 = 5(I - 2P) - 2P = 5I - 12P$$
$$P^2 + P^3 + P^4 = 4I - 9P$$
$$\Rightarrow a^2 = 4 : b^2 = 9$$

Q16

$$f(x) = (1+x)^{20}\left[1 + \frac{x}{1+x} + \left(\frac{x}{1+x}\right)^2 + \ldots + \left(\frac{x}{1+x}\right)^{18}\right]$$

$$(1+x)^{21}\left[1 - \left(\frac{x}{1+x}\right)^{19}\right] = (1+x)^{21} - (1+x)^2 x^{19}$$

Coefficient of x^{18} in $f(x)$ = Coefficient of x^{18} in $(1+x)^{21} = {}^{21}C_{18} = 1330$

Q17

$$f(x) + e^{f(x)} = \frac{2}{x} - \ln x - 1 \ldots(1)$$

Differentiate both sides

$$f'(x) + e^{f(x)}f'(x) = \frac{-2}{x^2} - \frac{1}{x} < 0 \forall x > 0$$

Hence, $\quad f'(x) < 0 \forall x > 0$

$\Rightarrow f$ is decreasing

Put $x = 1$ in equation (1) $\Rightarrow f(1) + e^{f(1)} = 1$

$\quad \Rightarrow \quad f(1) = 0$

$$f(2x^2 + 1) - f(x^2 + 5) \geq f(1), \quad f(1) = 0$$

$$f(2x^2 + 1) \geq f(x^2 + 5), f \text{ is decreasing}$$

$$2x^2 + 1 \le x^2 + 5$$
$$x^2 \le 4$$
$$-2 \le x \le 2, \text{ but } f : (0, \infty) \to R$$

so the x that satisfies the inequality belongs to $0 < x \le 2$

Q18

Given, $a^2 + b^2 + c^2 - ab - bc - ca \le 0$

$\therefore \frac{1}{2}\left[(a-b)^2 + (b-c)^2 + (c-a)^2\right] \le 0$

It is possible only $a = b = c$

Now, $\begin{vmatrix} (a-b+1)^5 & b^7 - c^7 & c^9 - a^9 \\ a^{11} - b^{11} & (b-c+2)^3 & c^{13} - a^{13} \\ a^{15} - b^{15} & b^{17} - c^{17} & (c-a+3)1 \end{vmatrix}$

$\Rightarrow \begin{vmatrix} 1 & 0 & 0 \\ 0 & 8 & 0 \\ 0 & 0 & 3 \end{vmatrix} = 24$

Q19
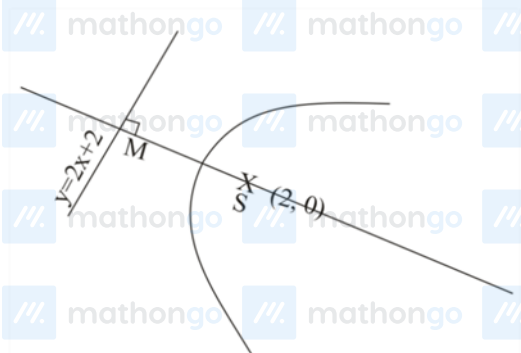
Length of $\text{LR} = 2(\text{SM})$

$= 2\,\dfrac{|2(2)+2-0|}{\sqrt{2^2+1}} = \dfrac{12}{\sqrt{5}}$

$\Rightarrow \dfrac{1}{K} = \dfrac{12}{\sqrt{5}} \Rightarrow K = \dfrac{\sqrt{5}}{12}$

Q20

Let $S = \tan^{-1}\left(\frac{1}{2}\right) + \tan^{-1}\left(\frac{2}{9}\right) + \tan^{-1}\left(\frac{1}{8}\right) + \tan^{-1}\left(\frac{2}{25}\right) + \tan^{-1}\left(\frac{1}{18}\right) + \ldots \ldots \infty$

$= \tan^{-1}\left(\frac{2}{4}\right) + \tan^{-1}\left(\frac{2}{9}\right) + \tan^{-1}\left(\frac{2}{16}\right) + \tan^{-1}\left(\frac{2}{25}\right) + \tan^{-1}\left(\frac{2}{36}\right) + \ldots \ldots \infty$

$T_n = \tan^{-1}\left(\frac{2}{(n+1)^2}\right)$

$S = \sum_{r=1}^{\infty} \tan^{-1}\left(\frac{2}{r^2 + 2r + 1}\right) = \sum_{r=1}^{\infty} \tan^{-1}\left(\frac{(r+2) - r}{1 + r(r+2)}\right) = \sum_{r=1}^{\infty} \tan^{-1}(r+2) - \tan^{-1}(r)$

$S = \lim_{n \to \infty} \tan^{-1}\left(\frac{3n^2 + 7n}{n^2 + 9n + 10}\right) = \tan^{-1}(3)$

Hence, $\tan S = \tan\left(\tan^{-1} 3\right) = 3$

Q21

The shortest distance between two lines $\overrightarrow{r} = \overrightarrow{a_1} + \lambda \overrightarrow{b_1}$ and $\overrightarrow{r} = \overrightarrow{a_2} + \mu \overrightarrow{b_1}$ is given by

$$\left| \frac{\left(\overrightarrow{b_1}\right) \times \left(\overrightarrow{a_2} - \overrightarrow{a_1}\right)}{\left|\overrightarrow{b_1}\right|} \right|$$

Given equation of lines

$$\overrightarrow{r} = \hat{i} + 2\hat{j} - 4\hat{k} + \lambda\left(2\hat{i} + 3\hat{j} + 6\hat{k}\right), \quad \overrightarrow{r} = 3\hat{i} + 3\hat{j} - 5\hat{k} + \mu\left(2\hat{i} + 3\hat{j} + 6\hat{k}\right)$$

Comparing with the standard form, we get

$$\overrightarrow{a_1} = \hat{i} + 2\hat{j} - 4\hat{k}, \ \overrightarrow{a_2} = 3\hat{i} + 3\hat{j} - 5\hat{k}, \ \overrightarrow{b_1} = 2\hat{i} + 3\hat{j} + 6\hat{k}$$

$$\left(\overrightarrow{a_2} - \overrightarrow{a_1}\right) = \left(3\hat{i} + 3\hat{j} - 5\hat{k}\right) - \left(\hat{i} + 2\hat{j} - 4\hat{k}\right)$$

$$= \left(3\hat{i} - \hat{i}\right) + \left(3\hat{j} - 2\hat{j}\right) + \left(-5\hat{k} + 4\hat{k}\right) = 2\hat{i} + \hat{j} - \hat{k}$$

Now,

$$\overrightarrow{b_1} \times \left(\overrightarrow{a_2} - \overrightarrow{a_1}\right) = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 3 & 6 \\ 2 & 1 & -1 \end{vmatrix}$$

$$\Rightarrow \left[\hat{i}\left(-3 - 6\right) - \hat{j}\left(-2 - 12\right) + \hat{k}\left(2 - 6\right)\right] = -9\hat{i} + 14\hat{j} - 4\hat{k}$$

Magnitude of $\overrightarrow{b_1}$

$$= \sqrt{2^2 + 3^2 + 6^2} = 7$$

The shortest distance is given by

$$= \left| \frac{-9\hat{i} + 14\hat{j} - 4\hat{k}}{7} \right| = \frac{\sqrt{293}}{7}$$

Hence, the value of K is 7.

Q22

$$g(x) = \frac{2}{e^4} \int_1^x \underbrace{2te^{t^2}}_{\text{II}} \underbrace{f(t)}_{\text{I}} dt = \frac{2}{e^4} \left(\left. \frac{f(t)}{t} \cdot e^{t^2} \right|_1^x - \int_1^x \left(\frac{f(t)}{t} \right)' e^{t^2} dt \right)$$

$$= \frac{2}{e^4} \left(\frac{f(x)}{x} \cdot e^{x^2} - 1 - \int_1^x t^2 dt \right) = \frac{2}{e^4} \left(\frac{f(x)}{x} \cdot e^{x^2} - 1 - \frac{1}{3}(x^3 - 1) \right)$$

$$g(x) = \frac{2}{e^4} \left(\frac{f(2)}{2} \cdot e^4 - 1 - \frac{8}{3} + \frac{1}{3} \right) = f(2) - \frac{20}{3e^4}$$

$$\Rightarrow (f(2) - g(2))3e^4 = 20$$

Q23

$$x\,dy = y(dx + y\,dy)$$

$$\Rightarrow y\,dx = (x - y^2)\,dy \Rightarrow \frac{dx}{dy} + \left(-\frac{1}{y} \right)x = -y$$

$$\therefore \quad \text{I.F.} = e^{\int -\frac{1}{y}dy} = e^{-\ln y} = \frac{1}{y}$$

$\therefore$ Solution of the given equation is

$$x \cdot \frac{1}{y} = \int -y \cdot \frac{1}{y}\,dy + c$$

$$\Rightarrow \frac{x}{y} = -y + c \dots \text{(i)}$$

Since $y(1) = 1$, i.e., $y = 1$ when $x = 1$

$$\therefore \quad 1 = -1 + c \Rightarrow c = 2$$

$$\therefore \quad \frac{x}{y} = -y + 2 \quad \dots [\text{From (i)}]$$

Putting $x = -3$, we get

$$-\frac{3}{y} = -y + 2$$

$$\Rightarrow y^2 - 2y - 3 = 0$$

$$\Rightarrow (y - 3)(y + 1) = 0$$

Since $y(x) > 0, y = 3$

Q24

We have $\csc^{-1} \csc 2 > x^2 - 3x \Rightarrow x^2 - 3x - (\pi - 2) < 0 \Rightarrow \frac{3 - \sqrt{1 + 4\pi}}{2} < x < \frac{3 + \sqrt{1 + 4\pi}}{2}$.

$\therefore$ Positive integral solution of above inequality are $1, 2, 3$.

Now $2010 = 2 \times 3 \times 5 \times 67$, total number of divisors of $2010 = 16$.

So A contains 3 elements and B contains 16 elements. Number of mapping are as follows :

$$f(1) < f(2) < f(3) \Rightarrow {}^{16}C_3 = 560$$
$$f(1) = f(2) < f(3) \Rightarrow {}^{16}C_2 = 120$$
$$f(1) < f(2) = f(3) \Rightarrow {}^{16}C_2 = 120$$
$$f(1) = f(2) = f(3) \Rightarrow {}^{16}C_1 = 16$$

Hence total mappings $= 816$

Q25

If $e \& e_1$ are eccentricity of hyperbola & in conjugate

$$\frac{1}{e^2} + \frac{1}{e_1^2} = 1 \quad \Rightarrow f(e) = \frac{e}{\sqrt{e^2 - 1}} \quad \Rightarrow fof(e) = e$$

$$\underbrace{fofo---f(e)}_{n \text{ time}} = \begin{bmatrix} e & \text{if } n & \text{ is even} \\ \frac{e}{\sqrt{e^2-1}} & \text{if } n & \text{ is odd} \end{bmatrix}$$

$$= \begin{bmatrix} 4 & \text{if } n \text{ is even} \\ 2\sqrt{2} & \text{if } n & \text{ is odd} \end{bmatrix}$$

Q26

We can represent the two scales as shown in the figure. We can clearly observe that the difference in degrees in the two scales must be equivalent. So,

$$\{150\,^\circ C - (-50\,^\circ C)\} = 100\,^\circ L - 0\,^\circ L$$

$$200\,^\circ C = 100\,^\circ L$$

$$2\,^\circ C = 1\,^\circ L$$

The melting point of water is $0\,^\circ C$. Difference between $-50\,^\circ C (= 0\,^\circ L)$ and $0\,^\circ C$ is $\{0\,^\circ C - (-50\,^\circ C)\} = 50\,^\circ C$.

$50\,^\circ C$ difference in temperature is equivalent to $\frac{50\,^\circ L}{2} = 25\,^\circ L$. So the melting point temperature in L scale will be,

$$t_1 = 0\,^\circ L + 25\,^\circ L = 25\,^\circ L$$

The boiling point of water is $100\,^\circ C$. Difference between $-50\,^\circ C (= 0\,^\circ L)$ and $100\,^\circ C$ is $\{100\,^\circ C - (-50\,^\circ C)\} = 150\,^\circ C$. $150\,^\circ C$ difference in temperature is equivalent to $\frac{150\,^\circ L}{2} = 75\,^\circ L$. So the boiling point temperature in L scale will be,

$$t_2 = 0°L + 75°L = 75°L$$

So, the melting point and boiling point of water are $25°L$ and $75°L$ respectively.

Q27
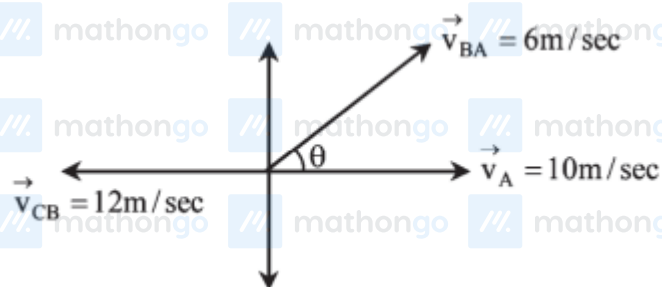
$$\cos\theta = \frac{15}{24}$$

$$\vec{v}_{BA} = \vec{v}_B - \vec{v}_A \Rightarrow \vec{v}_B = \vec{v}_{BA} + \vec{v}_A \dots$$
$$\&\ \vec{v}_{CB} = \vec{v}_C - \vec{v}_B \Rightarrow \vec{v}_C = \vec{v}_{CB} + \vec{v}_B$$

From (i) & (ii)

$$\vec{v}_C = \vec{v}_{CB} + \vec{v}_A + \vec{v}_{BA}$$

Here $\vec{v}_{CB} + \vec{v}_A = 2$ m/sec towards west

Finally, $|\vec{v}_C| = \sqrt{(2)^2 + (6)^2 + 2(2)(6)\left(\frac{-15}{24}\right)}$

$$= 5 \text{ m/sec}$$

Q28
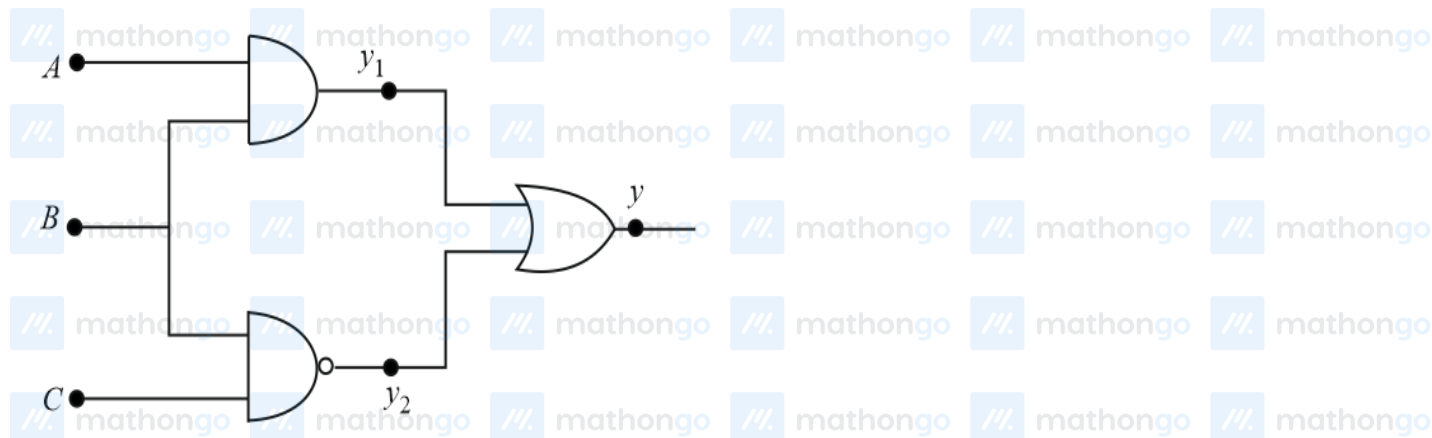
Truth table of AND gate for output y_1

A	B	y_1
0	0	0
0	1	0
1	0	0
1	1	1

Truth table of NAND gate for output1 y_2

B	C	y_2
0	0	1
0	1	1
1	0	1
1	1	0

Truth table of OR gate for output y

y_1	y_2	y
0	0	0

0	1	1
1	0	1
1	1	1
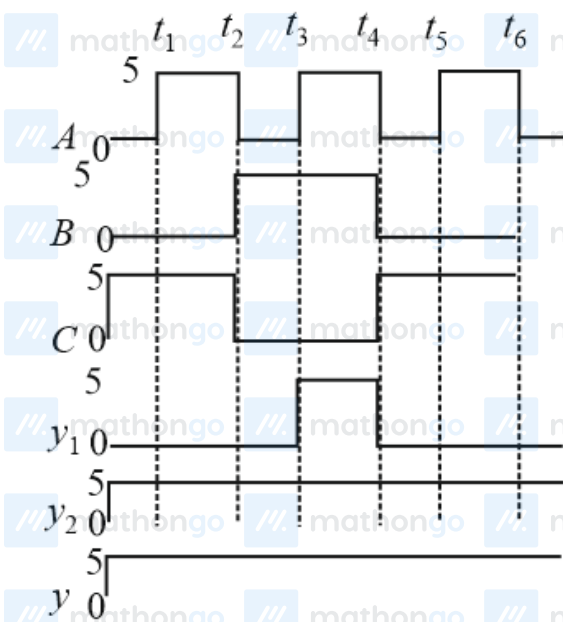
Q29

In a Young's double slit experiment for interference pattern, the position of bright fringe is given by

$$y_n = \frac{n\lambda D}{d}$$

Here,

$D = 1.5 \text{ m}$

$d = 0.3 \times 10^{-3} \text{ m}$

and

$n = 1; \lambda = \frac{y_n d}{D}$

For first violet, $y_n = 2 \text{ mm} = 2 \times 10^{-3} \text{ m}$

$\therefore \lambda_{\text{violet}} = 2 \times 10^{-3} \frac{d}{D}$

For first red,

$y_n = 3.5 \text{ mm} = 3.5 \times 10^{-3} \text{ m}$

$\lambda_{\text{red}} = 3.5 \times 10^{-3} \frac{d}{D}$

The difference in wavelengths of red and violet light is

$$\Delta\lambda = \lambda_{\text{red}} - \lambda_{\text{violet}}$$

$$= 3.5 \times 10^{-3} \frac{d}{D} - 2 \times 10^{-3} \frac{d}{D}$$

$$= \frac{d}{D}(1.5) \times 10^{-3}$$

$$= \frac{0.3 \times 10^{-3}}{15} \times 1.5 \times 10^{-3}$$

$$= 0.3 \times 10^{-6} = 0.3 \times 10^{-6} \times 10^3 \times 10^{-3}$$

$$= 300 \times 10^{-9}$$

$$= x \times 10^{-9} \text{ m} \quad (\text{given}) \quad \therefore x = 300$$

Q30

The process 1-2 is isobaric therefore work done by the gas is

$$W_{1\to2} = nR\Delta T = 2 \times R \times 300$$

$$W_{1\to2} = 600R = 4980 \text{ J}$$

The process 3-1 is isochoric therefore work done by the gas is zero.

Therefore,

$$W_{1\to2\to3\to1} = W_{1\to2} + W_{2\to3}$$

Also for cyclic process,

$$\Delta W = \Delta Q$$

$$W_{1\to2} + W_{2\to3} + 0 = \Delta Q$$

$$4980J + W_{2\to3} = -300J$$

$$W_{2\to3} = -5280J$$

Q31

Using Ampere's circuital law

$$B = 0 \quad \text{for} \quad r \leq R_1$$

$$B = \frac{\mu_0 i}{2\pi \left(R_2^2 - R_1^2\right)} \left(\frac{r^2 - R_1^2}{r}\right)$$

For $R_1 \leq r \leq R_2$

and $B = \frac{\mu_0}{2\pi} \frac{i}{r}$ $\quad r \geq R_2$

The corresponding $B - r$ graph will be as shown in
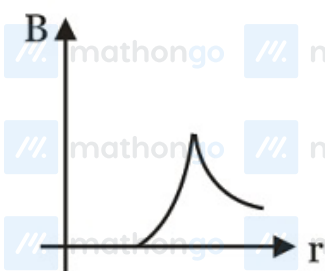
Q32

Let energy corresponding to the blue light is equal to the work function of the metal. If the frequency of incident radiation is greater than the threshold frequency, i.e., greater than the frequency of blue light for the given surface, a photoelectron can be emitted from it.

However, since red light has a lower frequency than blue light, it cannot eject photoelectron from the given surface.

Violet light has greater energy than blue light, while red light has smaller energy than blue light. As a result, violet light emits photoelectron while red light does not.

Now, the expression of the energy of the photon is $E = h\nu$, here ν is the frequency and h is Planck's constant.

Thus, from the above relation, we get, $E \propto \nu$.

Since violet light has a higher frequency than red light. As a result, violet light photons are more energetic than red light photons.

Q33

Moment of inertia of a rod of mass m And length l about its end is $\frac{ml^2}{3}$

Moment of inertia of a rod mass m And length l about its centre is $\frac{ml^2}{12}$

Moment of Inertia of the given system about Point C and perpendicular to plane can be calculated as
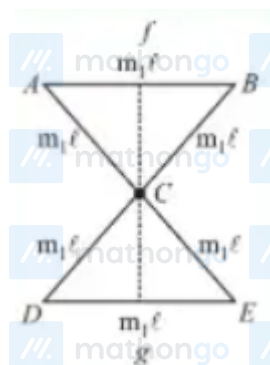
$$I = I_{AC} + I_{BC} + I_{CD} + I_{DE} + I_{AB} + I_{DE}I = \frac{ml^2}{3} + \frac{ml^2}{3} + \frac{ml^2}{3} + \frac{ml^2}{3} + I_{AB} + I_{DE} \text{ ...(i)}$$

Let's calculate Moment of inertia of $AB \& DE$ Using parallel axis theorem

$$I_{AB} = I_f + m(cf)^2 I_{AB} = \frac{ml^2}{12} + m\frac{3l^2}{4}$$

$$I_{DE} = I_g + m(cg)^2 I_{DE} = \frac{ml^2}{12} + m\frac{3l^2}{4}$$

Substituting the values of $I_{AB} \& I_{DE}$ in equation first we have

$$I = \frac{ml^2}{3} + \frac{ml^2}{3} + \frac{ml^2}{3} + \frac{ml^2}{3} + I_{AB} + I_{DE}I = \frac{4ml^2}{3} + 2\left[\frac{ml^2}{12} + \frac{3ml^2}{4}\right] = 3ml^2$$

Q34
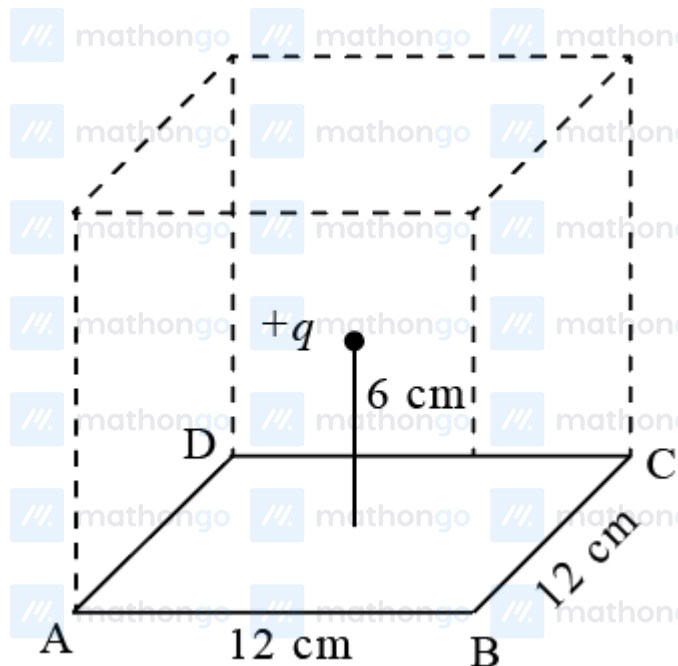
From figure, it is clear that square ABCD is one of the six faces of a cube of side 12 cm. By gauss's theorem, total electric flux through all the six faces of the cube $= \frac{q}{\varepsilon_0}$

Q35

Assertion:

The loop will have a tendency to expand because each current element in the loop experiences a magnetic force directed radially outward (due to Lorentz force $\vec{F} = I\vec{L} \times \vec{B}$). This causes the loop to expand.

So the assertion is true.

Reason:

The net force acting on a closed loop in an external uniform magnetic field is indeed zero. The forces on different segments cancel out.

The reason is also true, but this reason does not explain why the loop expands (expansion happens due to radial tension, not net force).

Q36

In spectral line series, wavelength is given by

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

For Balmer transitions,

$$n_f = 2$$

————————————————— $n_i = n$

$\longrightarrow \lambda$

————————————————— $n_f = 2$
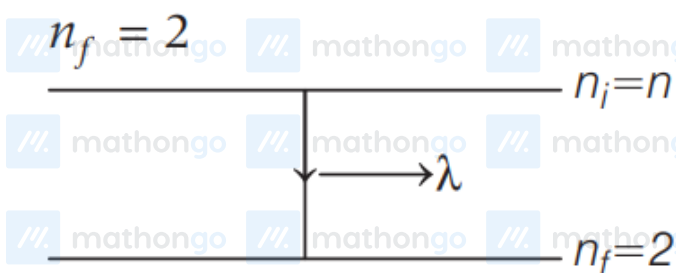
$$\Rightarrow \quad \frac{1}{\lambda} = R\left(\frac{1}{4} - \frac{1}{n^2}\right)$$

Given, $\lambda = \frac{16}{3R}$

$$\Rightarrow \quad \frac{3R}{16} = R\left(\frac{1}{4} - \frac{1}{n^2}\right) \Rightarrow \frac{3}{16} = \frac{1}{4} - \frac{1}{n^2}$$

$$\Rightarrow \quad \frac{1}{n^2} = \frac{1}{4} - \frac{3}{16} = \frac{1}{16} \Rightarrow n = 4$$

Q37
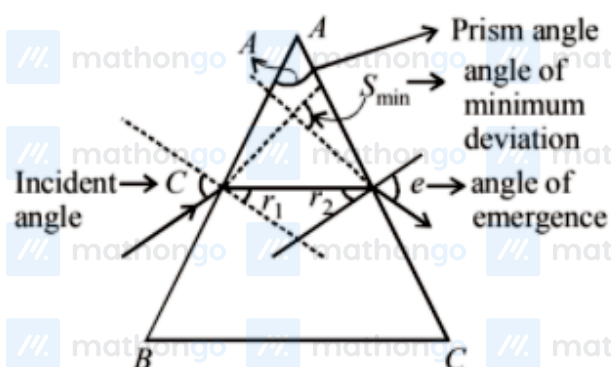
The angle of minimum deviation is given as

$\delta_{\min} = i + e - A$

for minimum deviation

$\delta_{\min} = A$ then
$2A = i + e$

in case of $\delta_{\min}, i = e$

$2A = 2i \quad r_1 = r_2 = \dfrac{A}{2}$

$i = A = 90°$

from snell's law

$1 \sin i = n \sin r_1$

$\sin A = n \sin \dfrac{A}{2}$

$2 \sin \dfrac{A}{2} \cos \dfrac{A}{2} = n \sin \dfrac{A}{2}$

$2 \cos \dfrac{A}{2} = n$

when $\quad A = 90° = i_{\min}$

then $\quad n_{\min} = \sqrt{2}$

$i = A = 0 \quad n_{\max} = 2$

Q38

Potential of the inner sphere

$V_A = \dfrac{kq}{r} + \dfrac{kQ}{R}$

Potential of the outer sphere

Hints and Solutions

MathonGo

$$V_\mathrm{B} = \frac{kq}{R} + \frac{kQ}{R}$$

$$\therefore V_\mathrm{A} - V_\mathrm{B} = \frac{kq}{r} - \frac{kq}{R}$$

$$= \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r} - \frac{q}{R}\right)$$
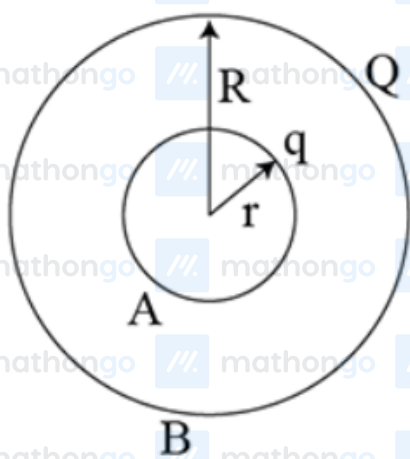
Q39

$$\lambda_{uv} < \lambda_v < \lambda_r$$

$$f_{uv} > f_v > f_r$$

Q40

Given, $PV^{\frac{5}{3}} = K$

Pressure $P = \left[\mathrm{ML}^{-1}\,\mathrm{T}^{-2}\right]$

Volume $V = \left[L^3\right]$

$$\Rightarrow \left[\mathrm{ML}^{-1}\,\mathrm{T}^{-2}\right]\left[L^3\right]^{5/3} = K$$

$\therefore$ Dimensions of $K = \mathrm{ML}^4\,\mathrm{T}^{-2}$

Q41

The rate of heat flow is given by

$$\frac{Q}{t} = \text{K. A.} \frac{\Delta T}{\ell}$$

Area of Original rod $A = \pi R^2$;

Areal of new rod $A' = \frac{\pi R^2}{4}$.

Volume of original rod will be equal to the volume of new rod.

$$\therefore \pi R^2 \ell = \pi \left(\frac{R}{2}\right)^2 \ell'$$

$$\Rightarrow \frac{\ell'}{\ell} = \frac{R^2}{\left(\frac{R^2}{4}\right)} = 4$$

$$\therefore \frac{Q'}{Q} = \frac{A'}{A} \frac{\ell}{\ell'} = \frac{1}{4} \cdot \frac{1}{4} = \frac{1}{16}$$

$$\therefore Q' = \frac{Q}{16}$$

Q42
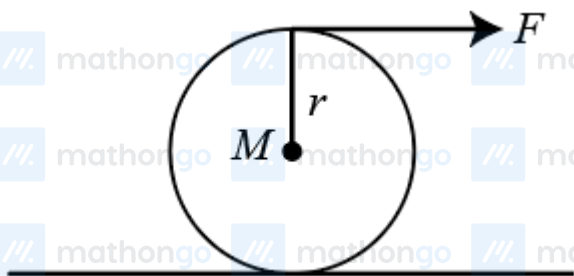
For Ring

$$\frac{F}{M} = a_{CM}$$

$$\Rightarrow \tau = I\alpha \Rightarrow Fr = I\alpha$$

$$\Rightarrow \alpha = \frac{Fr}{I} = \frac{Fr}{Mr^2} = \frac{F}{Mr}$$

$$\Rightarrow \tau = I\alpha \Rightarrow Fr = I\alpha$$

$$\Rightarrow \alpha = \frac{Fr}{I} = \frac{Fr}{Mr^2} = \frac{F}{Mr}$$

For pure accelerated rolling

$$a_{CM} = r\alpha$$

$$\frac{F}{M} = r\frac{F}{Mr}$$

$$\frac{F}{M} = r\frac{F}{Mr}$$

So, for ring there is no need of friction. Other than ring

$$I_{\text{other roling body}} < l_{\text{ring}}$$

Q43

Intensity of light after passing through polariser 1 is $I_0/2$. Intensity of light after passing through polariser 2 is $\frac{I_0}{2}\cos^2\theta$. Intensity of light after passing through polariser 3 is

$$I = \frac{I_0}{2}\cos^2\theta\cos^2(90-\theta) = \frac{I_0}{2}\sin^2\theta\cos^2\theta$$

So, for $\theta = 0$ or $90°, I = 0$

for $\theta = 45°, \quad I = I_0/8$

for $\theta = 30°, I = \frac{I_0}{2} \times \left(\frac{1}{2}\right)^2\left(\frac{\sqrt{3}}{2}\right)^2 = \frac{3I_0}{32}$

$\therefore 4$ is incorrect.

Q44

Assertion : It is not possible for a system, unaided by an external agency to transfer heat from a body at lower temperature to another body at higher temperature.

This statement is correct. It is a direct consequence of the Second Law of Thermodynamics. Heat naturally flows from hotter to colder objects. To transfer heat from a colder object to a hotter object, external work or an external agency is required (like in a refrigerator or a heat pump).

Reason : According to Clausius statement, "No process is possible whose sole result is the transfer of heat from a cooled object to a hotter object."

This statement is also correct. This is the Clausius statement of the Second Law of Thermodynamics. It explicitly prohibits a process where the only outcome is the transfer of heat from a colder to a hotter object.

Q45

Work done by magnetic field zero.

$$\Rightarrow mgy = \frac{1}{2}mv^2$$

$$v = \sqrt{2gy} \ldots (i)$$

$$ma_x = F_x$$

$$m\frac{dv_x}{dt} = qvB\cos\theta = qBv_y$$

$$\Rightarrow m\frac{dv_x}{dt} = qB\frac{dy}{dt}$$

$$mv_x = qBy$$

$$v_x = \frac{qBy}{m} \ldots (ii)$$

Speed will be maximum at lowest point $v = v_x$ at lowest point.

$$v = \frac{qB}{m} \times \frac{v^2}{2g}$$

$$\Rightarrow v = \frac{2mg}{qB} = \frac{2 \times 0.1 \times 10}{1 \times 2} = 1 \text{ m/s}$$
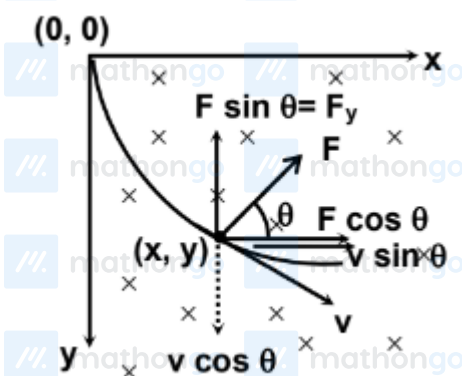
Q46

Given, $^a\mu_g = \frac{3}{2}, f_{\text{air}} = f$

$^a\mu_w = \frac{4}{3}$

Using lens Maker's formula, when lens is in air,

$$\frac{1}{f_{\text{air}}} = \left(^a\mu_g - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\Rightarrow \frac{1}{f} = \left(\frac{3}{2} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \text{...(i)}$$

$$\Rightarrow \frac{1}{f} = \frac{1}{2}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

When lens is immersed in water, then

$$\frac{1}{f_w} = \left(^w\mu_g - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \text{...(ii)}$$

Dividing Eq. (i) by Eq. (ii), we get

$$\frac{f_w}{f} = \frac{1}{2\left(^w\mu_g - 1\right)}$$

$$\Rightarrow f_w = \frac{f}{2\left(\frac{\mu_g}{\mu_w} - 1\right)} = \frac{f}{2\left(\frac{\frac{3}{2}}{\frac{4}{3}} - 1\right)} = \frac{f}{\frac{1}{4}} = 4f$$

$$\Rightarrow f_w = 4f$$

$\therefore$ Percentage change in focal length

$$= \frac{f_w - f}{f} \times 100$$

$$= \frac{4f - f}{f} \times 100 = 300\%$$

Q47

In the reference frame of the truck FBD of 40 kg block

Net force $\Rightarrow ma - \mu N \qquad \Rightarrow 40 \times 2 - \frac{15}{100} \times 40 \times 10$

$ma_{\text{biock}} \Rightarrow 80 - 60 \Rightarrow a_{\text{block}} \quad = \frac{20}{40} = \frac{1}{2} \text{ m/s}^2$

This acceleration of the block in reference frame of truck so time taken by box to fall down from truck

$$S_{\text{ret}} = u_{\text{ret}} t + \frac{1}{2} a_{\text{ret}} t^2 \Rightarrow 5 = 0 + \frac{1}{2} \times \frac{1}{2} \times t^2 \Rightarrow t^2 = 20$$

$m1$
(psuedo force)

μN
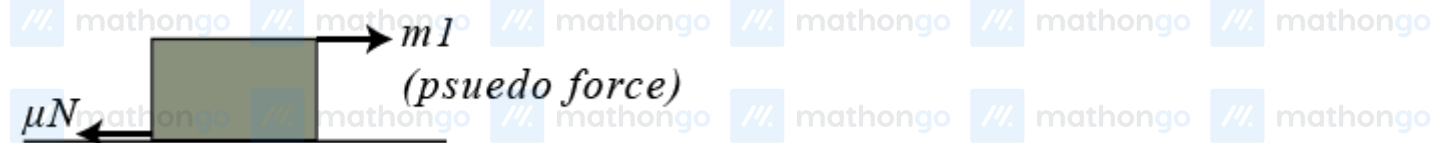
So distance moved by the truck

$$\Rightarrow \frac{1}{2} \times a_{\text{ruck}} \times t^2 \quad \Rightarrow \frac{1}{2} \times 2 \times (20) = 20 \text{ meter}$$

Q48

We know that pressure difference between surface point and a point at depth

$\Delta P = h d g$

$\Rightarrow \Delta\mathrm{P} = 200 \times 10^3 \times 10$

$\Rightarrow \Delta\mathrm{P} = 2 \times 10^6 \text{ N m}^{-2}$

Bulk modulus $K = -\dfrac{\Delta P}{\frac{\Delta V}{V}}$

$K = -\dfrac{2 \times 10^6}{\left(-\frac{0.1}{100}\right)}$

$K = 2 \times 10^9 \text{ N m}^{-2}$

Q49

$$X_L = \frac{V}{i} = \frac{125}{10} = 12.5\Omega$$

$$R = \frac{V}{i} = \frac{125}{12.5} = 10\Omega$$

$$X_L \propto f$$

$$\frac{X_L'}{X_L} = \frac{f'}{f} = \frac{40}{50}$$

$$X_{L'} = \frac{4}{5} \times 12.5 = 10\Omega$$

$$i = \frac{V}{z} = \frac{V}{\sqrt{R^2 + X_L^2}} = \frac{100\sqrt{2}}{\sqrt{10^2 + 10^2}} = 10 \text{ A}$$

Q50

$$V_0 = \sqrt{\frac{GM}{R}} \ \ldots\ldots (1)$$

$$V_e = \sqrt{\frac{G(8M)}{2R}} \ \ldots\ldots (2)$$

Given $\dfrac{M}{4/3\pi R^3} = \dfrac{M'}{4/3\pi\left(8R^3\right)} \Rightarrow M' = 8M$

$\Rightarrow V_e = 2V_0 \Rightarrow$ So $, n = 2$

Q51

The four lobes of $d_{x^2-y^2}$ orbital are lying along x and y axes, so, density in XY plane can't be zero.

The two lobes of d_{z^2} orbital are lying along z axis, and contain a ring of negative charge surrounding the nucleus in xy plane. So, the density in XY plane is non-zero.

2s orbitals have one spherical node, where the electron density is zero.

In $2p_x$ orbital, both the lobs lie along x axis. Hence, the density in yz plane is zero, thus it is the nodal plane.

Q52

The property stated against option (c) is incorrect.

The electronic configuration of given elements (ions) are

Cr^{2+} : $[\text{Ar}]d^4$ | 1 | 1 | 1 | 1 | | (4 unpaired e^-)

Mn^{2+}: $[\text{Ar}]d^5$ | 1 | 1 | 1 | 1 | 1 | (5 unpaired e^-)

Fe^{2+} : $[\text{Ar}]d^6$ | 1↓ | 1 | 1 | 1 | 1 | (4 unpaired e^-)
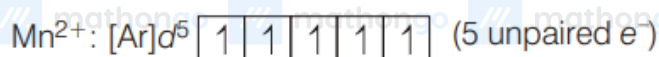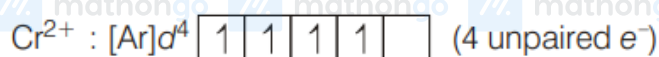
It is clear from above electronic configuration that Mn^{2+} has maximum number of unpaired electrons (5).

∴ It shown maximum paramagnetic behaviours among the given ions.

Q53

(i) NO_3^- CO_3^{2-}
(sp^2, trigonal   (sp^2, trigonal
planar)   planar)

Same hybridisation and same shape.

(ii) SO_2 NH_2^-
(sp^2, bent)   (sp^3, bent)

Different hybridisation and same shape.

(iii) XeF_2 CO_2
(sp^3d, linear)   (sp, linear)

Different hybridisation and same shape.

(iv) H_2O NH_3
(sp^3, angular)   (sp^3, pyramidal)

Same hybridisation and different shapes.

Q54
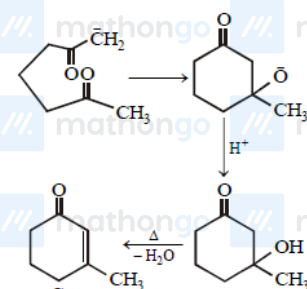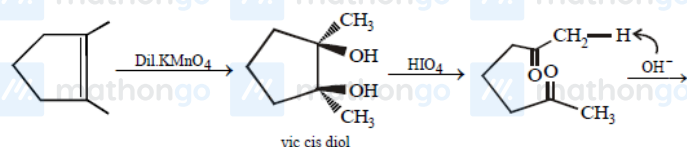
Q55

I : BrF_4^+ : Trigonal bipyramidal structure and see saw shape

II: Bond order of O_2 increases by the removal of e^-, as bond order increases

III : Br_3^- and Br_3^+ are of different shape and structure.

IV : In PCl_5, hybrid orbital of P is $sp^3d_{z^2}$

Q56

Electron releasing group increases basic character of amine and aromatic amine is less basic than aliphatic amine

Basic order $\propto$ + I or +M effect $\propto \frac{1}{-I}$ or $-\frac{1}{M}$ effect

Aliphatic amine is more basic than aromatic amine

Q57
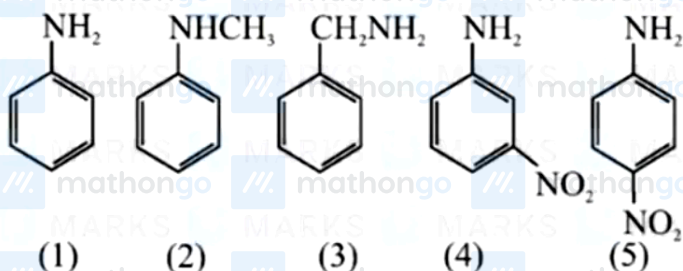
$E^o_{Cr^{3+}/Cr^{2+}} = -0.41$ V

$E^o_{Mn^{3+}/Mn^{2+}} = +1.57$ V

$E^o_{Fe^{3+}/Fe^{2+}} = +0.77$ V

$E^o_{Co^{3+}/Co^{2+}} = +1.97$ V

Reducing nature or tendency to get oxidized $\propto -E^o_{red}$

As more negative value of E^o_{red} indicates better reducing agent thus easily oxidized so oxidation of Cr^{2+} to

Cr^{3+} is the easiest.

Reducing nature for these metals is as follows Cr > Fe > Mn > Co.

Q58

At the start of any reaction, at t = 0, all reactants are present and no product is formed. As time

passes, the concentration of the reactants decreases and the concentration of the products

increases.

Time after which the concentration of both reactants and products becomes constant (may or may

not be equal) is called equilibrium time or the stage of equilibrium.

Here is the concentration versus time graph of any reaction, concentrations of both reactants and

products become constant after T_I, that is, time I.
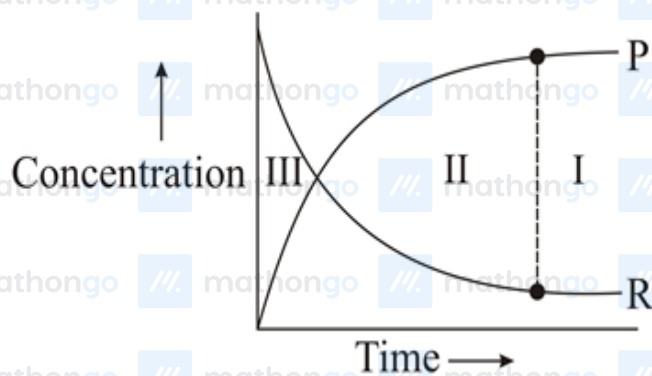
Thus, T_I is the equilibrium time.

Q59

Prussian blue is a deep blue pigment is $Fe_4[Fe(CN)_6]_3$.

Q60

Element	%	Relative no. of atoms	Simplest ratio of atoms
C	49.3	$49.3/12 = 4.1$	$4.1/2.74 = 1.5$
			$1.5 \times 2 = 3$
H	6.84	$6.84/1 = 6.84$	$6.84/2.74 = 2.5$
			$= 2.5 \times 2 = 5$
O	43.86	$43.86/16 = 2.74$	$2.74/2.74 = 1$
			$1 \times 2 = 2$

$\therefore$ Empirical formula $= C_3H_5O_2$

Empirical formula mass

$= (3 \times 12) + (5 \times 1) + (2 \times 16) = 36 + 5 + 32 = 73$

Molecular mass $= 2\times$ Vapour density

$= 2 \times 73 = 146$

$n = \frac{\text{molecular mass}}{\text{empirical formula mass}} = 146/73 = 2$

Molecular formula $=$ Empirical formula $\times 2$

$= (C_3H_5O_2) \times 2 = C_6H_{10}O_4$

Q61

When NH_4OH is added to the solution containing Cu^{2+} ions, deep blue solution is obtained.

$$Cu^{2+} + 4NH_4OH \rightarrow \underset{\text{deep blue solution}}{\left[Cu(NH_3)_4\right]^{2+}} + 4H_2O$$
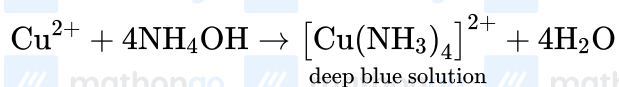
Hydrated cupric compounds absorb radiations corresponding to red light and the transmitted colour is greenish blue (which is complementary to red colour). Thus, cupric compounds give greenish-blue colour.

Q62

Bond order of $N_2 = 3$, bond order of $O_2 = 2$. Higher the bond order, shorter is the bond length and higher is the bond dissociation energy i.e., higher stability or lesser reactivity. Thus, N_2 is less reactive than O_2.

Q63

I $\log(a - x)$ (where $a - x$ is the remaining concentration), decreases with the passage of time.

II $kt = 2.303 \log\left(\frac{a}{a-x}\right)$

III For first order $t_{\frac{1}{2}}$ is independent of a

Q64

(A) $CH_3CH_2COOH \xrightarrow[\text{ii) } H_4O^+]{\text{i) } LiAll_4/ \text{ ether}} CH_3CH_2CH_2OH$

(B) $CH_3COCl \xrightarrow{R_2CuLi} CH_3COR$

(C) $CH_3COOH \text{ (vapours)} \xrightarrow[\Delta]{MnO} CH_3COCH_3$

(D) $CH_3CN \xrightarrow[H_3O^+]{SnCl_2/HCl} CH_3CHO$
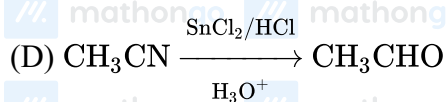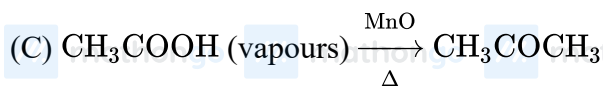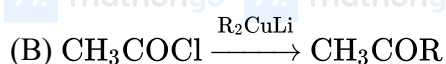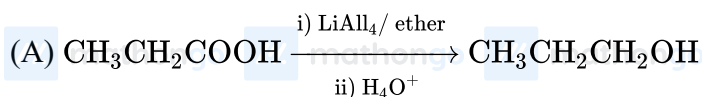
Q65

It is a salt of weak acid and strong base so acidic buffer is formed here, hence

$$pH = pK_a + \log_{10}\frac{[\text{Salt}]}{[\text{Acid}]}$$

Hints and Solutions

MathonGo

$$pH = -\log 5 \times 10^{-10} + \log\left[\frac{\frac{5 \times V}{V+10}}{\frac{10 \times 2}{V+10}}\right]$$

or $9 = -\log 5 \times 10^{-10} + \log\frac{V}{4}$

So V = 2 mL

Q66

Assertion: Ionization potential across the period is $Na < Al < Mg < Si$.

Based on the electronic configurations and the stability of filled and half-filled subshells, the order of the first ionization potentials for these elements is indeed $Na < Al < Mg < Si$.

- $Na(Z = 11) : [Ne]3s^1$

- $Al(Z = 13) : [Ne]3s^23p^1$

- $Mg(Z = 12) : [Ne]3s^2$

- $Si(Z = 14) : [Ne]3s^23p^2$

The first ionization potential of Mg is higher than Al because removing an electron from the completely filled 3s subshell of Mg requires more energy than removing an electron from the $3p$ subshell of Al.

Therefore, the assertion is true.

Reason: Ionization potential decreases with decrease in atomic size.

Generally, as we move across a period from left to right, the atomic size decreases due to increasing nuclear charge, and the ionization potential increases because the electrons are held more tightly by the nucleus.

Therefore, the statement that ionization potential decreases with a decrease in atomic size is false. Ionization

potential generally increases with a decrease in atomic size.

Since the reason is false, it cannot be a correct explanation for the assertion, even though the assertion is true.

Q67

Q68
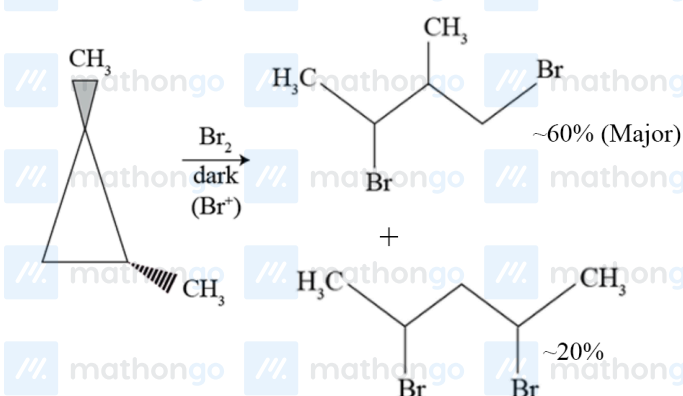
Presence of α-H atom is the main condition for exhibiting tautomerism.

The reactant taken in reaction (C) does not contain any α-H atom, thus the product (Y) will also show the absence of α-H atom, Hence, Y will not show tautomerism.

$(A) C_2H_8NH_2 \rightarrow$ W

Primary aliphatic amine $\rightarrow$ Carbylamine test $\rightarrow CH_3CH_2NC$ (ethyl isocyanide)

Hydrolysis of this gives propanal $(CH_3CH_2CHO) \rightarrow$ shows tautomerism.

(B) $(CH_3)_2CHNH_2 \rightarrow$ X

Branched primary amine $\rightarrow$ isocyanide $\rightarrow (CH_3)_2CH - NC$

Hydrolysis gives isobutyraldehyde $\rightarrow$ shows tautomerism.

(C) $(CH_3)_3CNH_2 \rightarrow Y$
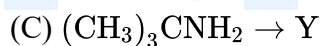
This is tert-butylamine $\rightarrow$ isocyanide $\rightarrow (CH_3)_3C - NC$

Hydrolysis gives $(CH_3)_3C - CHO$ (pivaldehyde)

But here's the key:

- The carbon adjacent to the carbonyl group has no a-hydrogens, so keto-enol tautomerism is not possible.

(D) $CH_3CH(NH_2)C_2H_5 \rightarrow Z$

This is secondary alkyl amine (still primary on NH_2 group) $\rightarrow$ forms isonitrile Hydrolysis gives a ketone (e.g., 2-pentanone) $\rightarrow$ has $\alpha - H$, so shows tautomerism

Q69

	Vitamin		Deficiency diseases
A.	Vitamin $- B_{12}$	3.	Pernicious
B.	Vitamin -B_6	4.	Skin diseases
C.	Vitamin - E	1.	Sterility
D.	Vitamin - K	2.	Haemorrhagic condition

Q70

$N_2 + \frac{1}{2}O_2 \rightarrow N_2O; \quad \Delta H = 28 \text{ kJ} \dots(i)$

$\frac{1}{2}N_2 + \frac{1}{2}O_2 \rightarrow NO; \quad \Delta H = 90 \text{ kJ} \dots(ii)$

By equation $[4 \times (ii)] - [2 \times (i)]$,

$2N_2O + O_2 \rightarrow 4NO$
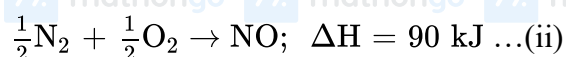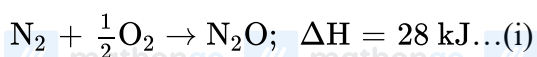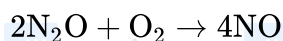
Hints and Solutions

$\Delta H = 360 - 56$

$\Delta H = 304$ kJ.

Q71

$= \dfrac{\text{Atomic mass of } X}{\text{Molecular mass of Ag}} \times \dfrac{\text{wt. of AgX}}{\text{wt of organic chelides}}$

$= \dfrac{80}{887} \times \dfrac{0.188}{0.2} \times 100 = 40\%$

Q72

$\Delta T_f = $ freezing point of H_2O - freezing point of ethylene glycol solution $= 0 - \left(-6^{\circ}\right) = 6^{\circ}$ C

$K_f = 1.86$ K kg mol^{-1}

$w_1 = $ Mass of ethylene glycol in grams

$w_2 = $ Mass of solvent (H_2O) in grams $= 4000$ g

$m_1 = $ Molar mass of ethylene glycol $= 62$ g mol^{-1}

$i = $ van't Hoff factor $= 1$ ($\because$ ethylene glycol is non-electrolyte)

From, $\Delta T_f = \dfrac{1000 K_f \, W_1(i)}{m_1 w_2}$

$\therefore 6 = \dfrac{1000 \times 1.86 \times w_1 \times 1}{62 \times 4000}$
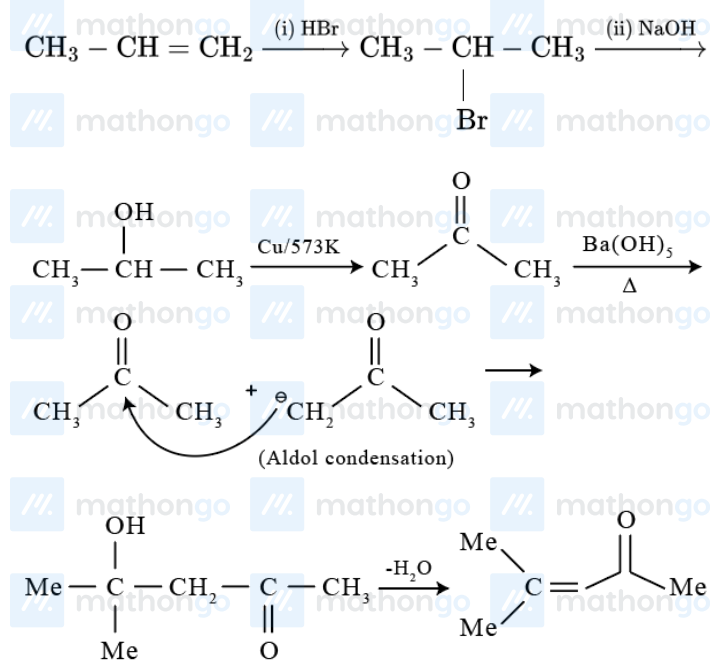
$w_1 = 800$ g

Q73

$E_a = \dfrac{k_1 E_{a_1} + k_2 E_{a_2}}{k_1 + k_2} = \dfrac{2E_1 + 4E_2}{6} = \dfrac{E_1 + 2E_2}{3}$

$x = 3$

Q74

Hints and Solutions

MathonGo

$$CH_3 - CH = CH_2 \xrightarrow{\text{(i) HBr}} CH_3 - \underset{\overset{|}{Br}}{CH} - CH_3 \xrightarrow{\text{(ii) NaOH}}$$

$$CH_3 - \underset{\overset{|}{OH}}{CH} - CH_3 \xrightarrow{\text{Cu/573K}} \underset{CH_3}{\overset{O}{\underset{\|}{C}}} CH_3 \xrightarrow[\Delta]{\text{Ba(OH)}_5}$$

(Aldol condensation)

$$Me - \underset{\overset{|}{Me}}{\overset{\overset{OH}{|}}{C}} - CH_2 - \underset{\overset{\|}{O}}{C} - CH_3 \xrightarrow{-H_2O} \underset{Me}{\overset{Me}{>}}C = \underset{Me}{\overset{O}{\overset{\|}{C}}}$$

Q75

Meq. of NaOH+ Meq. of Ba(OH)$_2$ = Meq. of HCl

X. $V_1 + 2Y. V_2 = 100 \times 0.1 = 10$

or $4Y. \dfrac{V_2}{4} + 2Y. V_2 = 10$

or $3YV_2 = 10$

$2Y. V_2 = 10 \times \dfrac{2}{3} = 6.66$

Fraction used by Ba(OH)$_2$ = $\dfrac{6.66}{10} = 0.67$